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INDEX.

VOLUME LXVI.

(VOLUME VI, NEW SERIES.)

1892.

ILLUSTRATIONS.

EDITORIALS.

EDITORIALS.

NEW PUBLICATIONS.

MISCELLANEOUS.

MISCELLANEOUS.

PERSONALS.

PERSONALS.

NOTES AND NEWS.

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(ESTABLISHED IN 1832.)

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NEW YORK, JANUARY, 1892.

THE chapter of the Essentials of Mechanical Drawing in the present number completes their publication in the JOURNAL. The author is now engaged in revising the articles as published, and they will be issued in book form, with some additions, as soon as the revision is completed.

OUR readers will note that the pressure upon our space has made it necessary to remove the "Index to Advertisements" from the cover to an inside page. At the same time, it has been made fuller than heretofore.

THE Drexel Institute in Philadelphia, which was formally opened December 17, owes its existence to Mr. A. J. Drexel of that city, who gave $1,500,000 for the building and endowment. It is intended to be a practical and industrial institution somewhat on the plan of the Cooper Institute in New York. It will have departments of art, science, business economy, etc., and a school for teachers, while combined with these are a museum and library. There will also be lectures and evening classes. The manual training system will have a prominent part.

AN experimental fast run was recently made on the Northern Railroad of France, from Paris to Calais, with a train of 12 passenger cars weighing 310,000 lbs. without the engine. The run of 185 miles was made with two stops, at the rate of 54 miles an hour actual running time. The highest speed attained was 67 miles an hour, on a down grade of 26.4 ft. to the mile; this was almost equaled on a level, where 66½ miles an hour was reached.

The locomotive which made this run had four driving-wheels coupled and a four-wheeled truck, the drivers being 83 in. in diameter. The engine is a four-cylinder compound of the Du Bousquet type, the cylinders arranged in tandem and the exhaust from the high-pressure cylinders passing directly through the valve into the low-pressure cylinders. The cylinders are 13.4 and 20.9 in. $\times$ 25.2 in.; the proportion between the high and low-pressure cylinders is 1 : 2.43. It may be added that this type of compound has been in use on freight trains on the Northern Railroad for some time, but has only been tried in passenger service very recently.

THE month of December was notable for the launching of three vessels for the Navy, and in another column will be found accounts of the great armored cruiser *New York*, the cruiser *Montgomery*, and the gunboat *Machias*, which were all put in the water during the month. Gunboat No. 6, a sister ship to the *Machias*, and the Naval Academy practice ship will follow soon, probably during the present month.

THE Nicaragua Canal had a very favorable mention in the President's message, and the New York Chamber of Commerce has passed resolutions expressing high appreciation of the advantages to be gained by its construction. It is becoming apparent that if the canal is to be built as a distinctively American enterprise, Government endorsement in some form will be needed. The demands for capital in the United States have been so great heretofore that our people have not become accustomed to investments outside of our own borders, and the difficulties of securing the money for an enterprise of the magnitude of the Nicaragua Canal are very great.

The canal ought to be built, and it ought to be under American control; the way is not quite clear at present, but it is to be hoped that some plan for providing the capital may soon be decided on.

PLANS for a triple-expansion locomotive have been made by a German engineer, who proposes to put the high-pressure and intermediate cylinders outside and the low-pressure inside, connecting all three with the same axle.

THE "Deep Water Ways Convention," which met at Detroit on December 17, had for its objects the urging upon Congress the importance of maintaining a depth of at least 21 ft. in the lake channels, and of ship communication between Lake Ontario and the Atlantic; the last to be attained by enlarging the Erie Canal by a new canal from Oswego through the Mohawk Valley to the Hudson, or by the St. Lawrence River. The last named could hardly be considered an American project, and was strongly opposed by the Eastern delegates.

THE construction of a ship canal from Lake Erie to Lake Ontario is proposed in a bill introduced in Congress by Senator Davis, of West Virginia. It provides for the building of a canal on one of the lines heretofore surveyed, the channel to be of a size sufficient to pass any vessel which can go through the locks on the Sault Ste. Marie Canal. The bill will not have much chance at the present session.

THE rapid transit question is almost at a stand in New York. The report of the Commission has been duly approved by the Mayor and Aldermen, and the work to be done at present is the obtaining the consent of property owners along the proposed lines. This proceeds slowly, and so far does not promise well, the consents obtained being chiefly of owners of uptown property, which will be benefited by the building of new roads, while in some of the streets further down-town there is active opposition. Meanwhile public opinion seems to be somewhat uncertain as to underground lines; at any rate, there is no strong feeling in their favor, and the present prospect of

any result from the work of the Commission is not encouraging.

THE present indications are that 1892 will be a good year for the car and locomotive builders. The heavy crops of the year just closed have caused a demand for freight cars, and there is everywhere a complaint of scarcity of rolling stock. For the first quarter of the year traffic will be large, and the railroad companies will be generally able to pay for the new cars they need. Moreover, many roads are looking forward to a heavy travel to the Chicago Exhibition next year, and will want new passenger cars to prepare for it. These considerations will apply to the locomotive business as well, and unless there is an unexpected change, there will be much new work.

SAFETY CAR COUPLERS.

THE latest scheme for securing the adoption and use of a uniform standard coupler is embodied in a bill recently introduced into the United States Senate by Senator Cullom.

The bill provides that all common carriers and all employers of such carriers whose duties include the coupling of cars, and who are members of established organizations of railway employés, may, within six months after the passage of this act, vote upon the choice of an automatic car coupler. Such coupler may be of the vertical type, but must be so devised as to couple by impact and to dispense with any person going between the cars to couple or uncouple.

Every common carrier is to be entitled to one vote for every freight car owned, leased, or controlled, and the employés entitled in the aggregate to one-third as many votes as may be cast by all the common carriers, the Interstate Commerce Commission to have the power to decide upon the validity of the votes cast. If not less than 600,000 votes have been cast, and the entire vote for any particular coupler is not less than 500,000, the commission shall certify these facts to the President, who shall issue a proclamation declaring the coupler chosen to be the standard safety car coupler for use in Interstate Commerce. And in case no choice is made, the President shall appoint a commission of five competent persons to determine the coupler best to be used. The bill further provides that all carriers are to equip at least 10 per cent. each year of the number of freight cars used, and also to equip every engine with the power brake known as the "driving wheel brake."

The bill provides further that a violation of the act shall be considered a misdemeanor and punishable by a fine of $500. The Commission may extend the time to any particular company within which it shall be required to comply with the provisions of the bill, and after the year 1900 any company may refuse to accept any car not equipped as required by the bill. The bill also provides that the commission shall invite bids from inventors of couplers, stating what they will accept from the United States for their patents, and upon the purchase of the patent by the Government the coupler may be used or manufactured by anybody free. The salary of the commissioners is fixed at $5,000 a year, and an appropriation of $70,000 is made to carry out the proposed measure.

The aim of this bill apparently is to secure, by a system of popular suffrage or a counting of noses, the selection from a vast multitude of inventions, which are the result of the exercise of the ingenuity of thousands of inventors, of an automatic coupler which will be most efficient in coupling cars, least liable to break or get out of order, and which will expose railroad operatives to the minimum amount of danger. It is safe to say that to make a wise decision on such a subject requires a very high order of mechanical knowledge and experience of the practical requirements which must be fulfilled by an automatic coupler, and more than all, an unerring judgment or "dead sureness" which, in combination with the other qualifications, is very rare indeed. Now what possible chance is there that the wisest decision will be reached by the method proposed in Mr. Cullom's bill? It provides that "all common carriers and all employés of such carriers whose duties include the coupling of cars, and who are members of established organizations of railroad employés, may vote upon the choice of an automatic coupler, and every common carrier to have one vote for every freight car owned, leased or controlled." The intelligence of the employés is evidently not rated very high, because they are entitled by the bill to only one-third as many votes as the freight cars are—that is, the bill in effect says that a railroad employé is endowed with one-third as much intelligence as the representation of a freight car confers on a common carrier. In other words, a general manager of a railroad which owns 50,000 freight cars would be assumed to have 150,000 times as much wisdom in deciding this question as a brakeman has. Now with due respect to brakemen and general managers, it may be said that neither of them have the highest qualifications to decide on the merits of automatic couplers. It is largely a mechanical question, and mechanical skill, knowledge, experience and sound judgment have more value in determining what coupler is the best than any other qualifications whatever.

If it was proposed to apply the method suggested by Mr. Cullom for providing a remedy for the risks and dangers of car coupling to the mitigation of some other risks and dangers to which mankind is exposed, its ineffectiveness would be apparent. Probably more people are disabled and die from the grippe than from coupling cars, and the doctors admit that they know of no sufficient remedy for the disease. Now supposing that, in view of the great loss of life and health resulting from the grippe, and the great need of a remedy, that some member of Congress was to introduce a bill giving all who have suffered from the disease a right to vote for a cure, and giving each hospital association a vote for every bed it provides, and then compel the doctors in the hospitals to administer the remedy thus agreed upon to their patients, we would be almost as likely to come to a wise decision on this subject as we will be in deciding upon a coupler by the Cullom plan. With reference to the medical question, the judgment, opinion and conclusions of a well-educated, intelligent, experienced and clear-headed doctor would be a safer guide in the adoption of a remedy for disease than the aggregate result of the counting of a great multitude of the noses of the sufferers from the ailment; and in the same way the opinion of a competent mechanical expert would be a very much safer guide in coming to a decision on the coupler question than any counting of noses can possibly be, and especially if two-thirds of those counted are the "bull-noses" of freight cars.

The bill also contemplates that "in case no choice is made, the President shall appoint a commission of five competent persons to determine the coupler best to be used; the salary of the commissioners is fixed at $5,000 per year."

The object aimed at by the popular suffrage part of the bill is not apparent. The decision of a commission of *competent* persons would certainly be safer to follow than the verdict of "not less than 600,000 votes." Then why not resort to the most trustworthy plan first? The question also arises whether a commission appointed by the President to "determine the coupler best to be used" will be as likely to consist of "*competent*" persons as it would be if this commission was created by the railroad companies. This leads to the subject which has already been discussed in these columns—that is, the creation of a

technical committee or commission by the American Railroad Association. The bill which we have been criticising seems to be a formal notice from Congress that if the railroad companies in the country will not take any adequate action to secure the adoption of uniform safety appliances, then Congress will do it for them. It will be impossible for the companies to successfully resist some national legislation of this kind unless they take adequate action looking to the same end. At present it can hardly be said that they are doing this. It becomes a question, then, whether the railroad companies will create a technical commission of their own, or whether they will have Congress do it for them. It may be said without hesitation that at present the railroad companies have no organization competent to deal with the question such as this one of automatic couplers. The members of the committees appointed by the various associations to consider such matters are not able, nor are they inclined if they could, to give the time which is required for the investigation and study of many of the subjects submitted to them. The real work of nearly all committees is, at any rate, generally done by some one member of each committee. Usually it is not well done, because no one is able to give the requisite time to the work. The need of the railroad companies is a commission with some one on it who is competent, who can give his whole time to the work and is paid liberally for doing it. Such a commission could be created by the American Railroad Association from its own members, or in part, perhaps, from members of the Master Mechanics' and Master Car-Builders' Associations, who would serve on it as the members of other committees do, merely as an advisory body, and without other compensation excepting expenses. They should be authorized to employ at an adequate salary a competent person or persons to do the work which should be done. Such a person could then give his whole time and thought to the work under the supervision and advice of the commission. In the exercise of his duties, he would accumulate much valuable experience and knowledge, and with each year his services would increase in value to those by whom he is employed. The difference in the results of the work which is done by a person who devotes his whole time, thought, energy and life to it, compared with that which is done casually and more or less perfunctorily, is the same as that which is always apparent when professional work is compared with that of an amateur.

The introduction of Mr. Cullom's bill makes it seem quite certain that if the railroad companies do not create some authority to act on questions like that of safety appliances, that Congress will do it for them.

Since the above was written, the full text of the bill has been submitted to us. Besides the above provisions, which were taken from a daily paper, it contains the following clause:

Section 10. That within 90 days from the passage of this Act the American Railroad Association is authorized hereby to designate to the Interstate Commerce Commission the standard height of draw-bars for freight cars, measured perpendicular from the level of the tops of the rails to the centers of the draw-bars, and shall fix a maximum variation to be allowed between the draw-bars of empty and loaded cars. Upon their determination being certified to the Interstate Commerce Commission, the Commission shall give notice of the standard fixed upon, at once, to all common carriers, owners or lessees engaged in Interstate commerce in the United States by such means as the Commission may deem proper, and thereafter all cars built or repaired shall be of that standard. *Provided also*, that after six months from said notice no cars shall be used in Interstate traffic which do not comply with the standard above provided for, either loaded or unloaded. Should said Association fail to determine a standard as above provided, it shall be the duty of the Interstate Commerce Commission to do so.

This latter clause is to be heartily commended; and in the interest of humanity it is to be hoped that it will become a law. The Master Car-Builders' Association has recommended a standard height for draw-bars—2 ft. 9 in., measured perpendicularly from the tops of the rails to the center of the draw-bar when the car is empty—but railroad companies are not generally conforming to it. If they are conforming to it the law will be no hardship; if they are not, they ought to be compelled to do so. We hope this part of Mr. Cullom's bill will become a law, but the rest of it is sure to work more harm than good.

INFORMATION REGARDING COMPOUND LOCOMOTIVES.

The Rhode Island Locomotive Works have issued another of their admirable reports of the performance of one of their compound locomotives on the New York, Providence & Boston and the Boston & Albany railroads. The results may be briefly summed up as follows: The compound engine weighed 103,230 lbs.; the simple engine on the Boston & Albany road weighed 91,250 lbs.; the one on the New York, Providence & Boston road weighed 91,000 lbs.

In the first series of trials on the New York, Providence & Boston road the compound engine showed a saving of 25.2 per cent. of coal. In the second series it saved 14.52 per cent. In the first series of trials on the Boston & Albany there was a saving of 28.63 per cent., and in the second series 21.6 per cent. While these results are very favorable to the compound engine, we think the conditions were hardly fair to the simple machine. In only one of the series of experiments was account kept of the amount of water evaporated per pound of coal. That was during the series of runs when the compound engine showed a saving of 14.52 per cent. During these tests the compound boiler evaporated 7.30 lbs. of water per pound of coal, whereas the simple engine evaporated only 6.59 lbs., so that nearly 11 per cent. of the saving was due to the boiler.

The difference in the boiler performance of simple and compound locomotives is usually attributed to the fact that compound engines use less steam than simple ones do, and therefore the boilers need not be worked so hard. In this instance, however, there was only about 3½ per cent. *more* water evaporated in the simple boiler than in the compound; and this, on the theory quoted, resulted in an increase of 11 per cent. in the amount evaporated per pound of coal. The explanation does not appear to be sufficiently explanatory.

Furthermore, the boilers of all the engines were practically of the same size; nevertheless, the compound engine weighed 12,000 lbs. more than the simple engines. It is true that the wheels of the compound engine were 6 in. larger than the one simple engine and 8 in. larger than those of the other; but it is fair inference that the greater portion of the difference in weight was due to the difference in construction between the compound and simple engines—that is, to the larger cylinders, additional steam pipes, intercepting valves, etc. Now to the extent to which the weight of compound locomotives is increased by their peculiarities of construction, to that extent are they a disadvantage. If the builders of the simple engines had been allowed to increase the size of their boilers

to the extent to which an addition of 12,000 lbs. to their weight would have permitted, doubtless the simple boilers would or could have shown better evaporative results.

The question is: How much better will a compound engine of a given weight do than a simple engine of the same weight? Not to hit a boy below your size is a rule that most of us learned in early youth, and the ethics underlying that rule applies to locomotives as well as to boys.

THE NAVY REPORTS.

THE report of the Secretary of the Navy emphasizes the progress made on the new vessels, and at the same time notes the rapid disappearance of the old wooden ships, few of which can be relied on for much longer service. The Secretary still adheres to the views expressed in his previous reports, and believes that we need more battleships of the class of the *Indiana* and *Massachusetts.* Beyond these he considers the armored cruiser with heavy armament, like the *New York*, the most useful and valuable class of ship that can be built for all purposes. For immediate addition to the Navy he believes that one or more torpedo cruisers, several torpedo-boats and one or more fast armored cruisers are the types most needed, with the addition of one or two light-draft vessels of good speed, with an armament of rapid-fire guns, for special river and in-shore service on the China and Asiatic stations. He does not recommend any increase in the number of cruisers of the *Detroit* or of the *Raleigh* classes.

The Secretary refers at some length to the recent tests of armor, and calls special attention to the fact that not only can the largest naval vessels be built in the United States, but that it is now possible to procure the best and heaviest armor and to make the complete armament in our own shops—a remarkable change during the past few years.

Upon the whole the recommendations of the report are well considered, and upon one point it is decidedly in the right. Time is required to build a modern warship, and if we are to have vessels at all, their building should be authorized in season.

On another point the report deserves commendation, and that is in its statement of the application of civil-service rules to the navy-yards, and the measures taken to improve the standard of the working force, and to secure really skilled labor. This policy is to be continued, and a resulting improvement is already to be noted.

Chief Engineer Melville has to report another busy year in his department. Fewer new designs for machinery have been called for; but there has been abundant work to do on the engines of the new ships, and the Bureau of Steam Engineering is fully occupied. Attention is called to the peculiar requirements in the engines of a warship and to the impossibility of meeting these and at the same time securing the same economy that is obtained in the merchant marine.

The question of improvement in the engineer force is a pressing one, and the difficulty of obtaining competent men to serve as machinists on board ship still exists. Competent men can do better on shore, and are not willing to submit to the restrictions of navy life. The need of skilled men increases with every improvement made in the new ships, and the supply is quite inadequate. Higher rating, better pay and a somewhat larger force are needed to secure the men. This difficulty is not peculiar to our own Navy, and it is the subject of serious consideration in England also. The modern warship depends so much for its efficiency upon its engineer force that the old-time complete subordination of the engineer to the fighting man can no longer be insisted on as it used to be. A full recognition of this fact would help very much to improve the present situation.

The report of Commodore Folger, Chief of the Bureau of Ordnance, has special interest this year, showing as it does the rapid progress which has been made in building heavy guns of the latest type. The great gun shop at the Washington Navy Yard is approaching complete equipment, and is already doing some notably excellent work. Not only are the 6-in., 8-in. and 10-in. guns being made ready for the new ships, but the first 12-in. gun has been tested, and several others are nearly ready, while work is in progress on the first of the 13-in. guns, the largest yet authorized. The building of an experimental gun of 16-in. caliber is recommended, and the Washington shop is ready to undertake the work. The smaller rapid-fire guns are now made in this country, and arrangements have also been made for the manufacture of armor-piercing shot.

Experiments with high explosives and torpedoes have been continued; and it is believed that the Bureau will soon be in a condition to supply the new ships with their equipment of torpedoes.

On the whole, the naval reports may be said to show good progress for the past year, with prospects of still further improvement in the future.

ENGLISH AND AMERICAN LOCOMOTIVES.*

(*Continued from page* 529, *Vol. LXV.*)

III.

SINCE the last number of the RAILROAD AND ENGINEERING JOURNAL was issued we have received a copy of the "Administrative Report on the Railways in India for 1890–91." This contains some interesting and valuable statistics relating to the performance of locomotives on Indian railways. As these lines are equipped with English locomotives, and as the nature of the traffic on them resembles that of our roads, a comparison of the performance of locomotives in that country with ours will throw some light on the question discussed in these articles.

In the year 1890 the total number of passenger, goods and mixed train miles run on the Indian railways was 72,645,950. It is not said whether this includes any mileage for switching or "shunting." Presumably it does not. If we allow 20 per cent. more for switching service we will have a total of 87,175,140 miles. The number of engines "used in conveying traffic" was 3,747, which would give an average mileage of 23,265 miles per engine, which is less than that of engines in the mother country, which was given in our November number, and it will be remembered was 24,160 miles, whereas the average mileage here was 35,650. Comment would not add to the significance of these figures. The railways of India are generally not profitable to their owners. Perhaps if they were equipped with American locomotives, which would run 50 per cent. more miles in a given time, and pull heavier

* We regret that the following mileage of locomotives on the Pennsylvania Railroad was received too late for publication in Table III, published in this series of articles in the November number of the JOURNAL. Locomotive No. 998 on that road ran 103,579 miles in the year 1886; locomotive No. 2107, on the Philadelphia & Erie division, ran 100,374 miles in 1888; locomotive No. 170, on the Philadelphia, Wilmington & Baltimore road, ran 126,152 miles in 1891. The latter beats the record.

TABLE VIII. SHOWING FUEL CONSUMPTION AND COST OF LOCOMOTIVE SERVICE ON TWELVE DIFFERENT AMERICAN RAILROADS.

1	Passenger Trains.								Freight Trains.							
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Name of Road.	Average Weight of Cars in Trains and their Loads in Tons of 2,240 Lbs.	Lbs. of Coal Consumed per Mile.	Value of Coal at 1 Mill per Lb.	Cost of Repairs per Engine, Mile.	Cost of Oil Waste and Miscellaneous Supplies per Mile.	Wages of Engineer, Fireman, and Cost of Cleaning per Mile.	Total Cost of Locomotive Service per Train, Mile.	Total Cost per Ton of Cars and of their Loads per Mile.	Average Weight of Cars in Trains and their Loads in Tons of 2,240 Lbs.	Lbs. of Coal Consumed per Mile.	Value of Coal at 1 Mill per Lb.	Cost of Repairs per Engine, Mile.	Cost of Oil Waste and Miscellaneous Supplies per Mile.	Wages of Engineer, Fireman, and Cost of Cleaning per Mile.	Total Cost of Locomotive Service per Train, Mile.	Total Cost of Locomotive Service per Ton of Cars and of their Loads per Mile.
	Tons.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Tons.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Chesapeake and Ohio	123.2	63.65	6.36	4.54	.29	6.59	17.78	.144	472.5	127.4	12.74	4.54	.29	6.59	24.16	.051
Chicago and Alton	139.7	72.3	7.23	3.62	.6	8.00	19.45	.139	508.0	96.1	9.61	3.62	.6	8.00	21.83	.041
Cincinnati Southern	117.9	55.0	5.50	4.4	.3	7.40	17.6	.150	570.0	98.0	9.80	4.4	.3	7.40	21.90	.038
Cleveland, Cincinnati, Chicago and St. Louis	122.8	63.21	6.32	3.19	.32	6.78	16.61	.135	535.0	106.7	10.67	3.19	.32	6.78	20.95	.039
Illinois Central	122.4	74.9	7.49	3.34	.28	6.46	17.57	.143	384.0	108.4	10.84	3.34	.28	6.46	20.92	.052
Louisville and Nashville	137.4	60.5	6.05	5.17	.27	7.98	19.47	.141	327.7	93.3	9.33	5.17	.27	7.98	22.75	.069
Michigan Central	147.0	72.7	7.27	3.36	.26	5.33	16.22	.110	800.0	128.0	12.80	3.36	.26	5.33	21.75	.027
New York, Lake Erie and Western	132.4	85.0	8.50	5.32	.41	8.18	22.41	.169	545.0	122.4	12.24	5.32	.41	8.18	26.15	.048
New York, Pennsylvania and Ohio	137.2	70.0	7.00	4.17	.31	7.60	19.08	.139	477.5	117.9	11.79	4.17	.31	7.60	23.87	.05
Pennsylvania (Philadelphia to Pittsburgh)	133.6	67.5	6.75	5.28	.50	6.22	18.75	.140	609.25	136.0	13.60	5.28	.50	6.22	25.60	.042
" (Lines West of ")	142.8	58.87	5.88	4.96	.32	6.74	17.90	.125	596.75	100.3	10.03	4.96	.32	6.74	22.05	.037
Philadelphia and Erie	106.9	60.0	6.00	6.29	.38	6.16	18.83	.176	816.5	153.8	15.38	6.29	.38	6.16	28.21	.034
Averages	130.3	......	......	......	......	......	18.47	43	553.5	......	......	......	......	......	23.34	.044

loads, the profits of the lines would be increased or their losses be diminished.

The report before us gives some data concerning the fuel consumption on the Indian railways, but it is difficult to get at their significance from the fact that the consumption on freight and passenger trains is not separated. The average consumption per train-mile—passenger and freight—on 14 lines was 41.67 lbs. of coal per mile. The "average" number of tons in a "goods train" on these roads was only 116.7 tons. Presumably this was the weight of the goods. This is only about a third of the weight of the freight in the average American trains given in Table V, published last month. On page 130 of the report the consumption of fuel "per 1,000 gross ton-miles" is given; but it is left in provoking uncertainty whether this means tons of freight or whether it includes the weight of cars or engines and tenders. The average consumption for 14 roads—excluding two which use wood for fuel—is 162.04 lbs. of coal per 1,000 gross ton-miles. If the weight of the engine and tender is included in the ton-miles, this consumption is high; if their weight is not included, it is low.

There are, however, other expenses besides the cost of fuel and repairs, attending locomotive service, in the transportation of freight and passengers, and which are dependent upon the efficiency of the locomotives. There is the cost of oil, waste, and other supplies, and the wages of enginemen and firemen, which are important items. It has been pointed out that the economy and the efficiency of locomotives are determined not by the fuel consumption alone, but by the total expenses which must be incurred to haul trains. These have been classified in Table II under the heads of Repairs, Oil Waste and Miscellaneous Supplies, and Wages of Enginemen, Firemen, and cost of Attendance and Cleaning. Evidently, too, in some kinds of traffic the relative cost of the wages of conductors and brakemen is affected by the capacity of the locomotives. Thus a train requires a conductor, and usually two, three, or four brakemen. Evidently if the engine pulls a heavy load this element of cost will be less, per ton of freight or per passenger, if many tons or passengers are hauled, than it would be if few are carried. For the present, however, we will take no account of this part of the expense, but confine what is said to those expenses which pertain directly to the locomotives.

As the cost of coal is a matter determined by local circumstances, and in order to make the conditions of the comparisons as nearly alike as possible, a common price of one mill, or one-tenth of a cent per pound, equal to $2.24 per ton, will be assumed for all roads. To arrive at the total cost of locomotive service of the 12 roads which report fuel consumption and train loads separately, we have tabulated the data contained in Tables II and III* in Table VIII, in which the cost of locomotive service is calculated per train mile and per ton of train per mile, at the same cost of coal—one mill per pound—for each road.

On this basis it will be seen in column 8 that the cost, including all the items given in the table, of locomotive service of passenger trains on the 12 American roads named is 18.47 cents, and from column 16 that of freight trains is 23.34 cents per mile. That of English trains, as shown in Table I,* including both passenger and goods, is 19.36; of Scottish, 14.66, and of Irish trains, 17.65 cents, the average being 18.72 cents. As the cost of traffic of British roads is not divided into passenger and freight expenses, it is not possible to compare the cost of these two classes of trains with that on American roads further than to observe that the cost per mile of passenger trains in this country is less than that of both classes of trains in

* Published in the November number of the JOURNAL.

England, and more than it is in Scotland or Ireland, and that the cost of locomotive service for freight trains is higher here than that of British freight and passenger trains. Without knowing the loads hauled, it is, of course, impossible to make any intelligent comparison of the cost of locomotive service. We have, however, calculated the cost per ton per mile, for both passenger and freight trains in this country, and, as shown by columns 9 and 17 of Table VIII, the average cost of locomotive service for passenger trains is .143 cents, and for freight .044 cents per ton per mile. As no data exists to show the weight of English trains, no comparison can be made on this basis.

From column 10 of the table it will be seen that the average weight of freight trains on the twelve roads included in the table was 553.5 tons. It is undoubtedly true that average English "goods" trains are not as heavy as the average of American freight trains given in the table; and it is safe to assume that the difference in weight is more than 25 per cent. The cost of locomotive service for American freight trains is 25 per cent. greater than that of all British trains. If the cost of goods trains in the United Kingdom is not less than that of passenger trains, then the cost of locomotive service per ton per mile of goods trains there must be greater than it is here. If the cost of such service for goods trains there is less than for passenger trains, then the cost for the latter must be more than 18.72 cents the average for all trains; and greater than the cost for such service on the 12 roads included in the above table. It follows then that unless the passenger trains on British roads are considerably heavier than on the lines given in the table, that the cost of locomotive service for such trains there must be considerably more than it is here. The average weight of all passenger trains on the 12 American roads given was 130.3 tons. Is the average weight of passenger trains on English, Scotch and Irish roads more or less than this?

It follows from this that unless the average weight of passenger trains is greater on British roads than it is on the American lines, of which we give reports, that the cost of locomotive service per ton per mile must be greater there than it is here. In this deduction there is some doubt about one of the premises—that is, with reference to the items of expense included under the head of "cost of working," of British engines. *The Engineer* should, however, be able to enlighten us with reference to this point, and, we hope, give some data concerning the average weight of trains on English roads. To again quote, or rather paraphrase, its own language against itself—"if our cotemporary cannot obtain them, on what grounds does it claim to represent English railways?"

The conclusion to be drawn from the data in Table VI is, that the average cost of locomotive service on American roads is only .143 cents per ton per mile for passenger trains, and .044 cents for freight trains; and that we do not know certainly what it costs on British roads, but there is a very strong presumption that, estimated on the same basis, it is considerably higher there than it is here.

An exact comparison is possible, however, if we compare Mr. Buchanan's trials with those made on the North British Railway, as the weights of the trains are given in both reports, and, as already mentioned, the average results are summarized in Table VII.* The value of the coal at one mill per pound for each road, the cost of repairs on each road, of oil, etc., on the New York Central, wages of engineers and firemen on both are all given. These expenses are added up for each road, and the sums are given in column 16, from which it will be seen that the total cost per train mile of locomotive service on the North British road is 17.63 cents, whereas on the New York Central it was 21.96. Each of these sums has been divided by the weight of the cars in the trains—given in column 6—and the result is given in column 17, from which it appears that the total cost of locomotive service per ton of train per mile was on the Scotch road .075 cents, whereas on the New York Central it was only .018 cents, or *less than one-quarter as much* as on the North British line.

But the comparison does not end here. As we have taken occasion to point out before, the total cost of locomotive service not only includes the cost of fuel, repairs, oil, etc., and wages of engineers and firemen, but in certain kinds of traffic the relative cost of the wages of conductors and brakemen, if apportioned per ton of freight carried per mile, is very much influenced by the train loads hauled. In Table VII the wages of conductors and brakemen on the New York Central have been given in column 18, and added to the total cost of locomotive service. The sum will be found in column 19. Dividing this total cost per mile for locomotive and train service by the weight of the train gives the total cost per ton per mile, which is given in column 20.

The same items were added to the North British expenses, excepting that it was assumed that for its shorter trains only two brakemen would be needed instead of three on the New York Central. Estimated in this way, it will be seen from column 20 that the cost of locomotive and train service in the North British trial per ton per mile was .096 cents, whereas on the American road it was only .023. In other words, *it was more than four times as great on the Scotch road than it was in the American trials.*

During the year 1890 the Pennsylvania Railroad lines east of Pittsburgh carried nearly 7,000,000,000 tons of freight one mile. If the locomotive expenses and cost of train services had been as great relatively to the tonnage hauled on this line as it was on the Scotch road, the expenses of the Pennsylvania company would have been increased over $5,000,000. These surely are weighty facts, which may, in part, account for the average freight rate on British roads being $1\frac{1}{4}d. = 2\frac{1}{2}$ cents per ton per mile, whereas here, on our through lines, it is a very little over one-half a cent.

It will be noticed in column 9 of Table VIII that the proportion of the weight of the North British engine to that of train hauled was as 1 to 6, and that the American engine pulled 22.6 times its own weight.

Now it may be that the experiments quoted by *The Engineer*, which were made in 1876–77, do not fairly represent the best English practice in the transportation of freight—and we doubt whether they do—but they are the best that are available for purposes of comparison and were quoted by our esteemed disputant, and it remains for him to either admit that they do not represent such practice, or if they do not to quote data which do. His failure to do either would be a virtual concession of the superior economy of American freight engines. The discussion of this subject will be concluded in our next issue.

(TO BE CONTINUED.)

* Published in the last number of the JOURNAL.

THE TRANSANDINE RAILROAD.

Album of Views of the Transandine Railway. Published for the Contractors.

This series of views contains 29 fine photographs taken on the line of the Transandine Railway, and includes some of the best views of mountain scenery we have ever seen. They illustrate very well the difficulties met in building the railroad, and show the rugged and picturesque scenery of the higher Andes. These views are accompanied by a description of the road.

The Transandine Railway is designed to connect Mendoza, the most westerly point reached by the Argentine railroad system, with Santa Rosa, the terminus of a Chilean line, among the foot-hills of the Andes; thereby completing the only transcontinental line in South America, and the only railroad from the Atlantic to the Pacific south of the Panama Railroad. The distance by rail from Buenos Aires to Valparaiso is 850 miles, and the gap to be filled by the new line was 150 miles. Of this the 110 miles from Mendoza to the Chilean line is owned by the Buenos Aires & Valparaiso Transandine Railway Company, and the 40 miles from the boundary line to Santa Rosa in Chile is known as Clark's Transandine Railway, the intention being to consolidate the two when completed. The enterprise owes its success so far to Don Juan and Don Mateo Clark, who obtained the original concessions, and have actively pushed the work. The line passes over the Uspallata Pass and the summit is 10,600 ft. above the sea. In this respect there is a considerable advantage over the two railroads which have thus far been carried over the Andes further north—the Lima & Oroya in Peru and the Antofogasta in Chile—both of which reach an altitude of 15,600 ft.

Numerous and careful surveys were made for the road, and in the final location the line was considerably shortened by the adoption of the Abt rack-rail system for several short sections, where grades of 12½ per cent. will be used.

Early in the present year the railroad on the Argentine side had been completed from Mendoza to Rio Blanco, 75 miles, while a further section of 12 miles, to Punta de las Vacas is nearly ready, leaving only 23 miles to be built. On the Chilean side it is finished from Santa Rosa eastward 23 miles, leaving 17 miles still to be completed. The 40 miles unfinished include the great summit tunnels, and extensive preparations have been made for the work. It is intended to utilize the water-power of the mountain streams, power being transmitted from the water-wheels to the points where it will be needed by electricity. The tunneling can be carried on from several different points, and will be all in hard rock, requiring no lining.

At present work is almost suspended, owing to the financial disturbances in the Argentine Republic and the revolution in Chile, but it is hoped that it will soon be actively resumed. A condensed description of the line is given as follows:

Leaving Mendoza at an elevation of 2,376 ft. above the sea, the line passes through vineyards and cultivated ground for 13 miles to the first station, Blanco Encalada. At the 15th mile the first important bridge is passed, a viaduct of six spans of 60 ft. each; it is not, however, until the Boca del Rio is reached at mile 19, that the railroad actually enters the gorge formed by the River Mendoza, and begins the ascent of the Andes. Here the very heavy work commences; after entering the gorge by a series of deep cuttings and a short tunnel, the line again crosses the Mendoza by a bridge of 148 ft., and before the 30th mile has been reached the river has been crossed five times by bridges of various spans from 148 to 246 ft. After passing the Paramillos Plain a tunnel is entered, followed at the 34th mile by another bridge of 246 ft. span; between this point and Uspallata station several tunnels have been pierced and the river has to be crossed again three times, twice by bridges of 246 ft., and once by a span of 197 ft. In addition to these heavy works there are many smaller bridges crossing the streams which flow down the side valleys of the Mendoza. Although the river is crossed so frequently, a number of tunnels and deep cuts were unavoidable, owing to the numerous spurs of the mountains. Bearing in mind that there was no road over which the heavy bridge girders could be carted, it is satisfactory that the line has been opened in so short a time from the commencement of the work in 1887.

From Uspallata to Punta de las Vacas the works are less difficult. They have been completed ready for traffic as far as Rio Blanco, and good progress has been made with the earthworks as far as Punta de las Vacas. Between Rio Blanco and the summit tunnels the first length of rack-rail has been introduced.

On the Argentine side there are four tunnels close to the summit, having a total length of 13,743 ft., and during the eight months preceding the stoppage of work last autumn the headings had been driven for a length of 5,628 ft., leaving 8,115 ft. of heading to be done; very satisfactory progress for eight months, half of which were winter months, when less work can be done.

On the Chilean side there will be five tunnels, the total length of which amounts to 36,630 ft., of which 3,846 ft. of heading have been driven during seven months, by hand labor only.

It will thus be seen that on the Chilean side out of a total length of 40 miles 23 are completed, and of the remaining 17 miles more than 7 miles are in tunnel.

The Transandine Railroad has an advantage over the two railroads already mentioned, which cross the Andes further north, in having a comparatively short section through unproductive territory. The Antofogasta Railroad is without local traffic for nearly 300 miles, and depends upon through business entirely, yet the results so far are satisfactory. The Lima & Oroya line has absolutely no local business after entering the mountains, and its sole dependence is the traffic of the Cerro di Pasco mines.

On the line of the Transandine there is already a large business in cattle, which are driven over the Uspallata Pass with much difficulty. There is also some passenger travel over the pass, which will be very largely increased when the road is finished, as the only competition will be with the steamers running between Buenos Aires and Valparaiso by the Straits of Magellan, a stormy and difficult passage which now takes about 12 days. Trains will be able to run through in less than two days. The traffic in general freight, now carried by steamer, is also considerable.

The Transandine is an important and notable line, and when completed it may fairly claim to be one of the great railroads of the world. It is to be hoped that the Messrs. Clark will soon be able to announce the full resumption of work.

NEW PUBLICATIONS.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. VOLUME XVI, 1890. Published by the Royal Engineers' Institute, Chatham.

The contents of this volume are about equally divided between matter of a purely military character and that which pertains to the domain of the civil engineer. Lieutenant-Colonel Saville discusses the question of the use of the cycle in future military operations, and gives some extraordinary examples of long distance riding. Mounted Infantry in Modern Warfare is discussed by Lieutenant-Colonel Hutton; and Captain Orde Browne brings down the record of Guns *vs.* Armor to the beginning of the present year. To the military reader the diagrams of English Service Ordnance are of particular interest. In a series of plates are given diagrams, drawn to scale, of the field, siege, garrison, machine and quick-firing guns in the English service, with their carriages and mounts, and so fully illustrated that the absence of descriptive text is scarcely noted.

Among articles of a more general interest is one on Bridges in the Bengal Presidency, by Sir Bradford Leslie. The presence of great rivers subject to extraordinary floods and of a soil thoroughly alluvial surround railroad, and especially bridge construction in India, with difficulties elsewhere unknown. The writer gives many interesting details of the devices resorted to for the protection of railroad bridges and embankments from the effects of a sudden and enormous rise in the waters. He

draws a graphic picture of the hand-to-hand struggle of the engineer with the annual inundations which sweep over the low-lying districts, when often the most untiring vigilance is powerless to prevent widespread destruction of railroad property, while the great heat and the presence of "cobras and other vermin" in the drift add greatly to his troubles at such times.

The paper on Road Making, by Mr. Percy Boulnois, is one we should like to place in the hands of every road engineer and county commissioner in the United States. The painstaking care given to the construction of even country roads in England and on the Continent would put to shame the slipshod way in which much of the city pavement is put down in this country. One acquainted with the country roads in some of the most prosperous parts of New York, Pennsylvania or Ohio—and they are often wretched makeshifts—may well wonder what the state of the country might be if this author's declaration be true that "the condition of the roads and streets of a community is the principal sign of its prosperity or otherwise."

COAL AND COAL CONSUMPTION IN SPANISH AMERICA. *Reports from the Consuls of the United States in Answer to a Circular from the Department of State.* Government Printing Office, Washington.

In this pamphlet the State Department has collected a number of consular reports from Central and South America and the West Indies on the fuel consumption and resources of different countries. It may be said that, with the exception of Chile and a few small mines in Mexico, no coal is mined throughout all the region named; some coal deposits are known to exist in Venezuela and elsewhere, but the stage of profitable working has not been reached. This lack of cheap fuel is the chief hindrance to the development of manufactures in most of the South American States. The United States ought to supply them with a large part of the fuel they need; and there is a possibility of the growth of a great coal trade. The information collected by the State Department will be of service to those who may be interested in building up such a trade.

SIXTH ANNUAL REPORT OF THE COMMISSIONER OF LABOR: COST OF PRODUCTION OF IRON, STEEL, COAL, ETC. Government Printing Office, Washington.

This report presents the results of an investigation made by the Bureau of Labor under the charge of Commissioner Carroll D. Wright into the relative cost of producing iron and steel and mining coal and iron ore in the United States, as compared with other countries. Mr. Wright's work is usually faithfully and intelligently done, and in this report he presents a great mass of information on the points indicated. The results are not in every case what might have been expected, but the comparisons are, in almost every case, full of interest. The investigation is not limited to the cost alone, but includes many particulars as to the condition of laborers, their earnings, cost of living and other similar matters.

The only objection to be made to the report is that its size prevents the careful study which one would like to make of it. The three volumes include 1,404 pages, and an attempt at a careful inspection gives one an idea of the amount of labor needed to collect and prepare the information.

THE ENGINE RUNNER'S CATECHISM. A SEQUEL TO THE STEAM-ENGINE CATECHISM. By Robert Grimshaw, M.E. John Wiley & Sons, New York; price, $2.

This book is intended as a guide to those who have to run stationary engines; it is, as the author says, intended to "treat more of special builds of engines as erected, adjusted and run, than of the properties of steam, or the general principles of engine design and construction."

It includes descriptions of a number of well-known types of stationary engines, with directions for setting, adjusting and running them, and also some general directions which are applicable to all engines. The descriptions and directions seem generally clear and plain, and the book should be a useful one. It is of small size, so that it can conveniently be carried in the pocket and kept ready for reference at any time. There is some good advice about foundations and the setting of engines. While there is little that is new, there is much that it is very convenient to have in a compact and accessible form.

TRAP SIPHONAGE AND TRAP-SEAL PROTECTION. By Professor J. E. Denton, M.E. The American Health Association, Concord, N. H.

This pamphlet is reprinted from the *Transactions* of the American Public Health Association, and contains a detailed account of an extended series of experiments in trap siphonage conducted, under Professor Denton's direction, at the Stevens Institute of Technology. These tests were intended to determine the relative capacity and degree of reliability of the several methods of preserving the trap-seal now known in plumbing practice. The results given are of much interest to architects, engineers, and all who have to do with building and sanitary arrangements. They should receive careful study.

SELECTED UNITED STATES PATENTS OWNED OR CONTROLLED BY THE THOMSON-HOUSTON ELECTRIC COMPANY, THE BRUSH ELECTRIC COMPANY AND ALLIED CORPORATIONS. The Thomson-Houston Company, Boston.

Some idea of the number of patents issued for electrical appliances may be obtained from the fact that this volume of 396 pages contains only those controlled by one corporation. With only a very brief introduction, the book gives the drawings and specifications in the form issued by the Patent Office. It contains altogether 81 of these specifications, the earliest in date being No. 217,677, issued to C. F. Brush, July 22, 1879, for a dynamo-electric machine. They cover numerous appliances of all kinds for dynamos, electric motors, electric railroads and other work of the kind. The book will be of service to electricians for reference.

THE PRACTICAL CATECHISM. *A Collection of Questions on Technical Subjects, and of the Answers Thereto.* By Robert Grimshaw, M.E., Ph.D. John Wiley & Sons, New York; price, $1.25.

This is simply a collection of notes made in answer to questions put to the author by many correspondents, and on a variety of subjects so great as almost to defy classification. Some 50 general topics are named in the index, ranging from Air, Alloys, Beams, through the alphabet to Waters, Weights, Wines, Work. It is fortunately accompanied by a complete index, so that the reader can find any particular topic about which he may be looking for information.

It is one of those miscellaneous collections which could hardly be criticised without going through every page carefully. The most that can be said is that the matter is arranged with some care, and that it can hardly fail to contain much information which is likely to be useful to a busy man. He may find what he wants in a condensed form, and so save himself the trouble of hunting it up from various sources. In this way the book will be found worth having and keeping for reference, while it will not supersede the use of other works.

TWENTY-SECOND ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS. State Printers, Boston.

This report contains a general statement of the work done under the direction of the Board during the past year, and

several special reports on various topics, such as the Health of Towns, Growth of Children, Food Inspection, etc., etc The larger part of the volume is occupied by reports on Water Supply and Sewerage, and their relations to the public health. These are in continuation of the work already done in the issue of the valuable reports on Water Supply heretofore issued by the Board, and referred to in our columns from time to time.

DIE UHRMACHERKUNST UND DIE BEHANDLUNG DER PRÄCISIONSUHREN (WATCHMAKING AND THE MANAGEMENT OF CHRONOMETERS). By Eugene Gelcich. A. Hartleben, Vienna.

This bulky volume of 640 pages, with 249 engravings, gives a complete account of the watchmaker's art, and is based on theory as well as practice, giving reasons for its directions and carefully worked-out formulas wherever they are applicable. Lack of familiarity with the details of watchmaking prevents a close criticism, which could only be intelligently made by one thoroughly acquainted with the art; but it may be said that the book is apparently thorough and carefully written. The chapters on the care of chronometers, stop-watches and what may be called time-keepers of precision, would doubtless be of interest to navigating officers of ships and others who have the care of such watches.

TABLES INCLUDING THE MOST FREQUENTLY USED VALUES OF NUMBERS. By Dr. H. Zimmerman. Ernst & Korn, Berlin, Germany.

In this German work Dr. Zimmerman has tabulated for the use of those who have to make calculations, the product of each number up to 999 by each number from 1 to 100; the square and cube of each number; the square root and cube root of each number; the reciprocal and the logarithm of each; the circumference and the area of a circle having each number for its diameter. There are also supplemental tables giving factors and natural logarithms.

These tables will doubtless save much time for those who have long and complicated calculations to make.

TRADE CATALOGUES.

The Uses of Mineral Wool in Architecture, Car-building and Steam Engineering. The United States Mineral Wool Company, New York.

This pamphlet contains an account of mineral wool, showing what it is, how it is made and the uses to which it may be put, with some directions for its application in cars, buildings, etc. This material is now in extensive use for covering boilers and steam pipes, filling in the spaces between the outside and inside sheathing of cars and buildings and for other similar purposes, and its excellent qualities are leading continually to its still more general use.

The term "wool" conveys to most people an idea of an animal substance, but mineral wool is "essentially a vitreous substance converted to a fibrous condition." It is made by converting scoria and certain rocks while in a molten condition into a fibrous state. The process is peculiar, and is covered by patents held by the company named above. The fibers are soft, pliant and elastic, like those of wool, but the substance in mass is incombustible, and is a non-conductor of heat; it is these properties which give it value, and they are fully explained in the pamphlet.

Pencils: the Joseph Dixon Crucible Company, Jersey City, N. J.

A circular very attractive to the editorial mind is issued by the Joseph Dixon Crucible Company in the shape of a bundle of excellent pencils of various grades. This company does not praise its own manufactures; it is quite willing to stand by the results of a trial of them.

The Florida Vestibule Limited. Passenger Department of the East Tennessee, Virginia & Georgia Railroad, B. W. Wrenn, General Passenger Agent.

The neatest and most tasteful railroad card we have ever seen is the time-card of the "Cincinnati & Florida Limited," issued by General Passenger Agent B. W. Wrenn, of the East Tennessee, Virginia & Georgia Railroad. Its design and execution are admirable, and it inspires one with a wish to travel over the line which sends out such a tempting invitation.

Tools: Illustrated Catalogue and Price List of Hammacher, Schlemmer & Company, New York.

BOOKS RECEIVED.

Annual Report of the Chief of the Bureau of Steam Engineering, Navy Department, for the Year 1891: *George W. Melville, Engineer-in-Chief, U. S. N., Chief of Bureau.* Government Printing Office, Washington.

Bulletins of the United States Geological Survey. Nos. 62, 65, 67–81, *inclusive.* Government Printing Office, Washington. These include some very valuable papers, notably No. 73 on the Viscosity of Solids; No. 74, on the Minerals of North Carolina; No. 75, Record of North American Geology, 1887–89; No. 79, on a late Volcanic Eruption in California; though there are others deserving especial mention.

Report of the Chief of the Bureau of Ordnance, Navy Department, for the Year 1891: *Commander William M. Folger, U. S. N., Chief of Bureau.* Government Printing Office, Washington.

Case School of Applied Science, Cleveland, O.: Catalogue for the Scholastic Year, 1891–92. Published by the School, Cleveland, O.

Reports of the Consuls of the United States to the Department of State: No. 132, *September,* 1891. Government Printing Office, Washington.

Report of the Commissioner of Railroads of the State of Michigan for the Year 1891: *Charles R. Whitman, Commissioner.* State Printers, Lansing, Mich.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending June 30, 1891. Government Printing Office, Washington.

Annual Report of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce of the United States for the Year ending June 30, 1891. Government Printing Office, Washington.

Annual Report of the Commissioner of Patents for the Year 1890. Government Printing Office, Washington.

World's Columbian Exposition, Chicago. Classification of Department of Transportation Exhibits: Railroads, Vessels, Vehicles. Willard A. Smith, Chief of Department. Issued by the Commission, Chicago.

Annals of the Society of Italian Engineers and Architects: No. 4, *Volume VI, August,* 1891. Published by the Society, Rome, Italy.

Colorado State Agricultural College, Experiment Station: Bulletin No. 13, *The Measurement and Division of Water. Bulletin No.* 16, *The Artesian Wells of Colorado and their Relation to Irrigation.* State Agricultural College, Fort Collins, Col.

The Eleventh Census. By Robert P. Porter, Superintendent. This is a reprint of an address delivered by Mr. Porter before the American Statistical Association in Boston in October last.

Royale Universita Romana, Scuola d'applicazione per gl' Ingegneri: Annuario per l'Anno Scolastico, 1891–92. Published by the Royal University, Rome, Italy.

The Philadelphia Record Almanac for 1892. The *Record* Publishing Company, Philadelphia.

ABOUT BOOKS AND PERIODICALS.

WE are requested by Mr. Robert Grimshaw to state that he is preparing a RECORD OF SCIENTIFIC PROGRESS IN 1891, which will be published by Cassells & Company, and that he would be much pleased to receive, from those who have done or who know of any noteworthy scientific work during the year, some particulars of the same. His address is No. 21 Park Row, New York.

In HARPER'S WEEKLY for December 9 there is a picture of the new Reading station in Philadelphia, which was illustrated and described in the JOURNAL for December. In the number for December 16 there is a four-page plate showing the buildings for the Columbian Exposition in Chicago, with an accompanying description.

The January number of SCRIBNER'S MAGAZINE begins the sixth year of that periodical. The articles include one on Bokhara and Central Asia; one on American Illustration, and a very interesting paper on Crime and the Law, by Recorder Smyth, of New York.

In the ECLECTIC MAGAZINE for December there will be found, as usual, a number of selections from the best English magazines and reviews. One of the articles which will attract attention is the last number of Mr. Murray's papers on Australia.

The January number of the POPULAR SCIENCE MONTHLY has another part of the article on American Pottery. Mr. D. A. Wells writes of Some Remarkable Bowlders, and Mr. Carroll D. Wright has an interesting study of Our Population and its Distribution. This number has an unusual number of illustrations.

The ARENA begins the new year with a number as free and aggressive as usual, and full of material for thinking people. The January number is fully up to the usual high standard in quality.

Among the articles in the JOURNAL of the American Society of Naval Engineers for November are papers by members on Fan Blowers; the Centrifugal Pump; some New Alloys; and Speed Curves of Ships building for the Navy. There are also abstracts and translations of several valuable foreign papers.

The number of HARPER'S MAGAZINE for January is one of unusual excellence, and contains a number of articles that will repay reading. This is the oldest of the monthlies, but shows no signs of age in its columns.

Besides the usual variety of stories and sketches, the OVERLAND MONTHLY for December has articles on the Defenses of the Pacific Coast; on the Dead Blue River and other lost rivers of California; on the Santa Barbara Islands, and on Flower and Seed Growing, an industry of considerable importance on the Pacific Coast. This magazine has made a very great improvement lately in the number and quality of its illustrations, and the December number has some excellent engravings. The January number is also to have some excellent illustrations.

Among the books in preparation by John Wiley & Sons, New York, is the MANUAL OF EXPERIMENTAL ENGINEERING, by Professor R. C. Carpenter, of Cornell University.

The January number of OUTING has illustrated articles on a variety of winter sports, with some excellent sketches and a few stories. Winter Photography is a paper which will interest many readers. The military article for the month is on the Active Militia of Canada; in it the author treats of the Northern Lake Forces.

In the COMPASS for December the article on Series of Numbers is continued, and there are also articles on the Pantograph, on the Plain Transit and on Speedy Calculators.

In GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for December there are articles on the Trade Winds; the Unexplored Regions of Canada; Self-Purification of Rivers; Trans-Siberian Railroad Routes, and a number of shorter ones of much interest. This magazine is of wider scope than its special title would indicate, and almost any intelligent reader will find in it something to interest him.

IT may interest some of our readers to know that Government publications, if they cannot be secured through some member of Congress, can usually be bought at a fixed price from J. M. Hickox, 905 M Street, W., Washington. The same party issues a monthly catalogue of all Government publications, which can be obtained by subscribing.

AN OLD-TIME FAST LOCOMOTIVE.

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The Eleventh Census. By Robert P. Porter, Superintendent. This is a reprint of an address delivered by Mr. Porter before the American Statistical Association in Boston in October last.

Royale Universita Romana, Scuola d'applicazione per gl' Ingegneri: Annuario per l'Anno Scolastico, 1891-92. Published by the Royal University, Rome, Italy.

The Philadelphia Record Almanac for 1892. The *Record* Publishing Company, Philadelphia.

ABOUT BOOKS AND PERIODICALS.

We are requested by Mr. Robert Grimshaw to state that he is preparing a Record of Scientific Progress in 1891, which will be published by Cassells & Company, and that he would be much pleased to receive, from those who have done or who know of any noteworthy scientific work during the year, some particulars of the same. His address is No. 21 Park Row, New York.

In Harper's Weekly for December 9 there is a picture of the new Reading station in Philadelphia, which was illustrated and described in the Journal for December. In the number for December 16 there is a four-page plate showing the buildings for the Columbian Exposition in Chicago, with an accompanying description.

The January number of Scribner's Magazine begins the sixth year of that periodical. The articles include one on Bokhara and Central Asia; one on American Illustration, and a very interesting paper on Crime and the Law, by Recorder Smyth, of New York.

In the Eclectic Magazine for December there will be found, as usual, a number of selections from the best English magazines and reviews. One of the articles which will attract attention is the last number of Mr. Murray's papers on Australia.

The January number of the Popular Science Monthly has another part of the article on American Pottery. Mr. D. A. Wells writes of Some Remarkable Bowlders, and Mr. Carroll D. Wright has an interesting study of Our Population and its Distribution. This number has an unusual number of illustrations.

The Arena begins the new year with a number as free and aggressive as usual, and full of material for thinking people. The January number is fully up to the usual high standard in quality.

Among the articles in the Journal of the American Society of Naval Engineers for November are papers by members on Fan Blowers; the Centrifugal Pump; some New Alloys; and Speed Curves of Ships building for the Navy. There are also abstracts and translations of several valuable foreign papers.

The number of Harper's Magazine for January is one of unusual excellence, and contains a number of articles that will repay reading. This is the oldest of the monthlies, but shows no signs of age in its columns.

Besides the usual variety of stories and sketches, the Overland Monthly for December has articles on the Defenses of the Pacific Coast; on the Dead Blue River and other lost rivers of California; on the Santa Barbara Islands, and on Flower and Seed Growing, an industry of considerable importance on the Pacific Coast. This magazine has made a very great improvement lately in the number and quality of its illustrations, and the December number has some excellent engravings. The January number is also to have some excellent illustrations.

Among the books in preparation by John Wiley & Sons, New York, is the Manual of Experimental Engineering, by Professor R. C. Carpenter, of Cornell University.

The January number of Outing has illustrated articles on a variety of winter sports, with some excellent sketches and a few stories. Winter Photography is a paper which will interest many readers. The military article for the month is on the Active Militia of Canada; in it the author treats of the Northern Lake Forces.

In the Compass for December the article on Series of Numbers is continued, and there are also articles on the Pantograph, on the Plain Transit and on Speedy Calculators.

In Goldthwaite's Geographical Magazine for December there are articles on the Trade Winds; the Unexplored Regions of Canada; Self-Purification of Rivers; Trans-Siberian Railroad Routes, and a number of shorter ones of much interest. This magazine is of wider scope than its special title would indicate, and almost any intelligent reader will find in it something to interest him.

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steel rails for 1893 delivery amounted to 600,000. This indicates an improvement over 1891, and a prospect for better business than last year.

THE iron ore shipments from the Lake Superior region for the season of 1891 were 6,490,205 tons, showing a decrease of 19½ per cent. from those of 1890. These shipments were well taken up by the furnaces, only a little over 1 per cent. of the total being reported as in stock unsold at the receiving ports.

THE total freight movement through the Sault Ste. Marie Canal for the season of 1891 was 8,888,759 tons, which is 1½ per cent. only below that of 1890; a remarkable result when the falling off in iron ore shipments is considered.

THE result of the biddings for mail service under the Postal Subsidy Act of last year has been hardly what the advocates of the law anticipated. The few contracts let have been for third and fourth-class service, with one exception, and nearly all cover existing lines. The only contract for the second-class is also for a new line, and is for service from New York to Buenos Aires and Montevideo, once in three weeks; it is not to begin until December, 1894. No contract for first-class service has been let under the act.

THE tables of the English *Lloyd's Register* show that there were added to the world's mercantile fleet last year 1,362 vessels, with a total tonnage of 1,646,809 tons. Of these 482 ships of 318,268 tons were sailing vessels, and 880 ships of 1,328,541 tons were steamers. In sailing vessels the United States built 28 per cent. of the total tonnage, but in steamships only 6½ per cent. As to material, 780 of the ships were of steel, 145 of iron, 14 composite and 423 of wood.

It is notable that for several yeast past there has been a steady increase in the number of wooden vessels and of sailing vessels built, a reaction in favor of wood having apparently set in. On the other hand, steel has almost entirely superseded iron as a ship-building material.

THE business of the elevated roads in New York showed last year an increase of about 5 per cent. only; the figures from the Manhattan Company's report for the year ending September 30 are:

	1891.	1890.
cond Avenue line	32,574,091	33,479,216
nue line	77,978,822	73,258,192
xth Avenue line	69,254,641	62,907,323
Ninth Avenue line	19,520,387	18,559,146
Total	199,327,941	188,203,877

There was an actual falling off on the Second Avenue line, but this was probably due to the fact that the Suburban Elevated which at first connected only with that line, was last year extended so as to transfer passengers to the Third Avenue.

Elevated road growth does not seem to have hurt the surface lines, for the Third Avenue Road last year carried 35,000,000 passengers—the largest number ever noted.

THE Khojak Tunnel, the completion of which has recently been announced, is one of the great tunnels of the world. It carries the Indian Frontier Railroad under the summit of the Khojak Pass in the Himalaya Mountains, and is 12,600 ft. long. The workings were carried on from both ends and from two intermediate shafts, and have been chiefly in hard rock, the greatest delays coming from seams full of water, met with from time to time.

The Frontier Railroad is a Government work, and is built entirely for military reasons. It extends from the terminus of the Indian railroad system at Quetta to Candahar, and its object is to aid in supporting English influence in Afghanistan, and perhaps also to prepare for the time when an English army at Kabool will have to face a Russian force from Merv with the Trans-Caspian Railroad at its back.

THE report of the Chief of Engineers in relation to coast defense states that the sums appropriated last year have been used chiefly in providing casemates and other sites for heavy guns at New York, Boston and San Francisco, the guns for which are under construction by the Ordnance Department. Plans have been prepared for fortifications for Portland, Philadelphia, Washington, Charleston and Hampton Roads, and for the extension of those at New York and San Francisco. The casemates or batteries now under construction do not include any of the proposed iron or steel protected works, but are generally of concrete covered with sand, and the use of disappearing carriages has generally been kept in view in designing batteries.

AMONG the other work which the Navy has had in hand during the year is the work of extending surveys for the inside channel along the Atlantic seaboard. The general design which has been considered by the Navy Department in preparing its part of the scheme for coast defense has been the opening of the Cape Cod Canal, so that torpedo-boats and gun-boats of moderate draft could proceed from Boston through the canal along Long Island Sound; thence by existing canals, the Delaware River and Chesapeake Bay to Hampton Roads, then by the Albemarle & Chesapeake Canal and the sounds along the coast of Florida. It would be possible to secure a channel with at least 8 ft. of water for the whole distance with comparatively little work, and the value of such an interior waterway in case of war can easily be estimated; while at the same time its formation would be of very great benefit to commerce. In addition to this, it is proposed to improve the channels along the New Jersey coast, so that vessels might be able to proceed from Cape May to Atlantic City, and from thence to the head of Barnegat Bay, without obstruction.

THE problem of generating electricity direct from heat, without the intervention of the steam-engine and dynamo, has occupied the attention of electricians for some time, and now Mr. Edison has, according to the *Safety Valve*, so far succeeded that he has applied for a patent for his invention, giving the following general description: "The object I have in view is to generate electricity directly from carbon, coal, or other carbonaceous material, without the loss caused by the indirect method heretofore employed of converting the same into a motive power, from which electricity is produced by mechanical motion. This I accomplish by employing carbon or carbonaceous material for the generating or soluble electrode of a generating cell and in using therewith as an active agent oxides, salts or compounds of elements, by the decomposition of which the carbon or carbonaceous material will be acted upon at high temperatures. The cell is constructed and adapted for the application of heat externally thereto, and the conducting or negative electrode of the cell is made of a substance which in the presence of carbon at high temperatures is not attacked to any great extent by the active agent employed."

A CORRECTION.

AMONG the Current Notes in the November number of the JOURNAL (page 489) was the following:

> Since the article in the October number of the JOURNAL (page 455), on the increased strength obtained by oil-tempering and annealing steel forgings, was published, we have received particulars of another test. In this case a steel crank-pin was taken, the chemical analysis being as follows: Carbon, 0.050; manganese, 0.060; silicon, 0.150; phosphorus, 0.035 A specimen ½ in. in diameter and 2 in. between marks, cut longitudinally from the pin, after treatment stood the following tests: Tensile strength, 112,040 lbs.; elastic limit, 61,170 lbs.; elongation, 20.55 per cent.; contraction of area, 45.53 per cent. These are notable results

In some unaccountable way the decimal points in the chemical analysis of the steel given above were misplaced, and it ought to read as follows: Carbon, 0.50; manganese, 0.60; the silicon and phosphorus being correctly given. This statement will make the item intelligible.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXIV.—STEEL FOR SPRINGS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 554, Vol. LXV.*)

The question of what kind of steel to use in springs, both spiral and elliptical, or flat bar springs, is one that has received a good deal of study in both the Laboratory and in the Mechanical Engineering Department of the Pennsylvania Railroad Company. The necessity for this study will become apparent when it is stated that ten years ago it was not at all uncommon to have a pile of broken sprial springs, removed from freight cars at the important places where repairs are made, large enough to load four or five cars. Indeed, it seemed as though it was the general rule that the springs would break after a few months' service rather than that they would continue in service for a long period of time. This applied especially to the bolster and draw-bar springs of freight cars. The elliptical or flat bar springs, both on cars and locomotives, have never given anything like the trouble; but even in these two kinds of service, the difficulties have been sufficient to warrant a good deal of attention to the subject.

It may be interesting to state that on careful examination and testing by well-known formulas derived from Reuleaux's work on this subject, it was found that the design and metal used in the spiral springs on the Pennsylvania Railroad from eight to ten years ago was of such a kind that the metal was actually strained in certain forms of springs even beyond its tensile strength, when the spring was brought down solid. It will doubtless be remembered that the form of spring most commonly in use ten years ago was an oval bar coiled on its edge; and the strain in the metal of many of these springs, figured by Reuleaux's formulas, showed that when the spring was brought down solid, in almost all cases the elastic limit of the metal was exceeded, and in many cases the actual tensile strength of the metal was exceeded. It was no wonder, therefore, that the springs broke in service, since, in addition to holding up the load, which may be called the static strain in the metal, there are likewise, as is well known, in actual service many strains introduced into the spring which cannot be calculated, due to side thrust on striking a curve, owing to the elevation of the outer rail on a curve, and to inequalities in the track.

In view of the state of affairs above described, very careful study some eight or ten years ago was put upon the question of the kind of steel to be used in springs, and also upon the question of design. The form in which the metal should be put, and the weight of the steel used, together with the detail drawings and the different kinds of spiral springs ultimately decided upon, will, it is hoped, be treated later on. This article will be confined especially to the quality of the steel; and it will be sufficient to say, in regard to the design, that, as is well known, it was ultimately decided to use in spiral springs only round bars, and that the design only strains the metal 80,000 lbs. per square inch when the spring is brought down solid. As a preliminary to deciding upon both the design and chemistry of the steel, or, in other words, what kind of steel shall be used, quite a large number of round and flat bars of specified chemical composition were obtained from two or three of the most reliable spring steel makers. One half of these bars were tempered and the other half were annealed, and the whole lot was then sent to the big Government testing machine at Watertown Arsenal to be broken and the physical properties carefully obtained. Following this came an analysis of the steel, and upon this data—namely, the results of physical test obtained from the large testing machine and from the analyses of the samples—the specifications were drawn up.

In the service there are three uses of steel for springs: first, *spiral* or *helical* springs, mostly used on freight cars, and also used somewhat on passenger cars, cabin cars, and maintenance of way cars, and in various places throughout the service; second, *double elliptical* springs, most largely used on passenger cars, and also in other parts of the service as occasion may require; third, *half elliptical* springs, used on locomotives. Definite chemical specifications have been prepared for the steel used in all kinds of spiral springs, and for the steel used in locomotive springs. No chemical specifications have yet been prepared for the double elliptical springs used under cars. Up to the present time this kind of springs has been bought from the best makers, and as the laboratory is in constant consultation with these people, it is pretty well understood what metal is used. It seems probable that definite specifications may be prepared at no distant day for the steel used in this class of springs also. The chemical specifications for locomotive spring steel are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

SPECIFICATIONS FOR LOCOMOTIVE SPRING STEEL.

Steel for locomotive springs must be delivered in sizes and lots as ordered, and each bar when received must be free from physical defects, including cracks along the edges and seams, and must stand the operation of being cut into proper lengths cold, by the ordinary process of nicking and breaking over the edge of the anvil.

Bars which vary more than (0.01) one one-hundredth of an inch in thickness, or more than (0.02) two one-hundredths in width from the size ordered, or which break where they are not nicked, or which when properly nicked and held, fail to break square across where they are nicked, will be returned and must be replaced free of charge.

The metal desired has the following composition: Carbon, 1.00 per cent.; manganese, 0.25 per cent.; phosphorus—not over 0.03 per cent.; silicon—not over 0.15 per cent.; sulphur—not over 0.03 per cent.; copper—not over 0.03 per cent.

Shipments will not be accepted which show on analysis less than 0.90 or over 1.10 per cent. of carbon, or over 0.50 per cent. of manganese, 0.05 per cent. of phosphorus, 0.25 per cent. of silicon, 0.05 of sulphur, and 0.05 of copper.

Theodore N. Ely,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., August 1, 1887.

It will be observed that these specifications cover the questions of variations from size, as well as the chemistry of the metal. It will also be observed that there is no special physical test for this kind of metal. The chemistry of the metal and the size of the bars, together with the breaking over the anvil, are all the tests made. In regard to breaking over the anvil, it may be said in explanation that the bars are received in lengths too long, of course, for use, and that it is customary to cut them up into leaves by nicking them and breaking them over the anvil. It sometimes happens that the steel is so irregular that the break is not square across the nick, and sometimes also a piece will break 2 in. away from the nick rather than at the nick. This is of rare occurrence, but is always regarded as evincing lack of uniformity in the metal, possibly due to irregular heating or working too cold, resulting in over-tempering, or due to too rapid cooling by throwing the bars into water or allowing the rain or snow to fall on them after they are finished. Of course if a bar breaks in this way there is considerable lost metal, and the specifications are drawn to cover this point.

It is believed that these are the only possible specifications for this kind of steel, since, as is well known, steels containing as much carbon as is required above are more or less inclined to take temper according to the temperature at which they are passed through the rolls the last time, and also in proportion to the rate of cooling, so that

steel entirely uniform in composition might show very wide variation in physical test, depending on the temper, and the physical specification would therefore have to be of such wide limits, unless perchance special annealing of the test pieces should be made use of, that the physical test would be of very little value. On the other hand, since we always heat this steel, and always temper it before it goes into service, the actual condition of the steel as received from the manufacturers as evinced by the physical test would be of very little value to us. Accordingly the quality of the steel is measured wholly by its chemistry.

As is customary in our specifications, it will be noted that a pattern analysis is given, and that this is followed by the limits on which rejection will take place.

Taking up now the items in detail; it will be observed that we desire 1.00 per cent. carbon in our spring steel, and that if the amount is less than 0.90 or above 1.10 per cent. we reject. At first we thought to give simply a lower limit in carbon, but we soon found that we received metal as high as 1.25 per cent. and sometimes as high as 1.30 per cent. carbon, and of course steel so high in carbon would not, under the same treatment in the shop, both in working under the hammer and also in tempering, give uniform results. We were compelled, accordingly, to limit the amount of carbon. There is no data in our possession to show that we could not use with perfect success a steel running, say, from 1.10 to 1.20 per cent., or 1.15 to 1.25 per cent. carbon; but we do think it essential to have certain limits, both upper and lower, in order that there may be enough uniformity in the metal, so that the shops will be able to turn out uniform work. The question of the amount of carbon in spring steel has been the subject of a great deal of controversy. We are well aware that the carbon we require is much higher than is the practice in Europe, and, indeed, much higher than most of the spring-makers were using at the time these specifications were adopted. Some of the large steel manufacturers remonstrated with us over these limits, and, indeed, were quite certain that a serious mistake had been made in placing the limit of carbon so high. An experience now of some five or six years with these limits of carbon in springs has apparently confirmed the wisdom of the choice, as will be set forth a little later in speaking of spiral springs.

It may not be amiss to mention here, in regard to the limit of carbon in steel for springs, that special attention was given to this subject by one of us during a trip to Europe in 1886. It was found that the general European practice seemed to be about 0.70 to 0.75 per cent. carbon in spring steel. On several occasions those in charge of large spring establishments were asked why they used steel so low in carbon, since it was quite evident that the strength of the metal was increased and a smaller amount of metal would hold up the load if higher carbon steel were used. The reply was that the manufacturers were making steel to sell, and were not studying the subject in the interest of the railroad companies. In confirmation of this point it will doubtless be remembered by those who have given the matter attention, that the customary thickness of a leaf in flat bar springs in Europe is from ½ to ⅝ in., while in this country ⅜ in. is rarely exceeded in thickness. It seems as though there could be little doubt as to which is the wiser practice; and as far as our experience has gone, we have seen no occasion to regret placing the carbon as high as is given in the above specifications.

The question of the manganese in steel for springs has likewise been the subject of considerable controversy. The manufacturers, when these specifications were issued, were divided. Those who were anxious to make steel for springs by the crucible process wanted us to place the limit not above 0.20 or 0.25 per cent., so as to keep out steel made by the open-hearth or Bessemer process. On the other hand, those who were interested in the open-hearth or Bessemer process, and in a few cases the crucible people, wanted a higher limit of manganese, on the ground that it would be impossible to make spring steel so high in carbon in the open-hearth furnace if the manganese was as low as 0.20 or 0.25 per cent. The crucible people, who wanted high manganese, thought a better metal could be obtained by allowing the manganese to run as high as 0.60 or 0.70 per cent. In view of this conflicting data, it was decided—possibly a little arbitrarily—to make the limit 0.50 per cent.; and nothing has arisen thus far in the service to indicate that this limit was a seriously objectionable one. We are quite well aware that a good many open-hearth people think that a much better limit would be 0.60 per cent. manganese, and we really know of no reason why such a limit should not be allowed. It is claimed by these people that they are a little more certain of getting solid ingots if the maganese runs as high as 0.60 per cent. We are having and have had no difficulty in securing a steel which does not exceed the limits of manganese mentioned, and apparently the manufacturers have learned to meet the requirements without any serious trouble.

The question of phosphorus has likewise been the subject of some controversy and difficulty. It is well known that in the market to-day the phosphorus is the element which practically fixes the price. A material which will make a steel containing not over 0.03 per cent. phosphorus is easily worth $5 per ton more than a material which will make a steel containing 0.08 per cent. phosphorus, and as competition naturally drives down prices, the tendency is to use a steel containing the higher amount of phosphorus. We have spent considerable time and study over the question of phosphorus in steel for springs, and are frank to say we do not know where the safe limit is. Some of the steel manufacturers think our limits in locomotive spring steel are full high even now. Others are inclined to think we could go still higher with safety. Within the last two years we have made careful analyses of some 20 broken spiral springs taken from the service to see whether any relation could be discovered between the breakage and the phosphorus, since it is well known that the common influence of phosphorus is to render the steel brittle, especially when the carbon is high. These 20 analyses showed nothing practical. About one-half the broken springs were even below 0.05 per cent phosphorus, some of them as low as 0.03 or 0.035 per cent., while the other half were between 0.05 and 0.09 per cent. It will be obvious, with a little thought, that the chemistry of the metal is not the only cause for the breakage of springs. The design of course has a very important influence, and also the temper. It is hoped and believed that our design of spiral springs is perfectly satisfactory, but we had no means of measuring the temper of these broken springs, which were analyzed as above stated, and consequently we were in doubt as to whether the breakage was due to over-temper or high phosphorus. It seems clear that in part of the cases it must have been due to over-temper. In the others it may have been assisted, or possibly may have been due wholly, to the high phosphorus. The question therefore still remains unsettled, and we do not know what the safe limit of phosphorus is. The tendency in spiral springs is toward an increase in the use of phosphorus, and it is probable that sooner or later we will be able to say what the safe limit is. More recent analyses of the phosphorus in spiral springs indicate that we are commonly getting steel containing as high as 0.06 or 0.08 per cent. of phosphorus.

With regard to the silicon and sulphur, we are inclined to think that high silicon is to be avoided as much as possible, on account of the fact that the material is worked by blacksmiths in a fire, and, as is well known, silicon oxidizes much more rapidly than iron in a fire. In other words, our experience indicates that the silicon is more important in the working of the metal in the fire than anywhere else, and the rather high limit which we have given—namely, 0.25 per cent., was introduced only to allow crucible steel to still come in, since, as is well known, it is impossible to make steel in the crucible without having somewhere from 0.15 to 0.25 per cent. silicon. If the steel could be made successfully by both the open-hearth and crucible processes, we would prefer a steel containing not over 0.05 per cent. silicon in steel for springs.

No positive relation has been discovered so far as we know between the sulphur and the value of the steel for springs. We are inclined to use as low sulphur as we can get, and the limit was placed with this idea in mind.

The same remarks apply to a certain extent with regard to the copper in steel. We do not know what the safe limit of copper is, and the limit placed is more of an arbitrary one than one based on positive knowledge. We have some experiments in progress on this point, and hope to have some definite information within six months or a year as to the actual influence of copper on spring steel. Until that information can be obtained, we of course keep the copper as low as we can.

The first specifications for locomotive spring steel were issued not quite four years ago, and they have not yet been revised. They have worked with very great satisfaction; and the difficulties in shop manipulation have been less, we are confident, than before the specifications were adopted. It is natural that this should be so, since a uniform product has been furnished the shops.

The chemical specification for the steel to be used in making spiral springs is as follows:

Manufacturers must furnish for chemical test one extra spring for every 500 or fraction thereof of Classes A, U, V, W, X and Y springs shipped, and one extra spring for every 300 or fraction thereof of all other classes shipped. These springs for chemical test will be chosen by the Inspector at random from the lot ready for shipment, and he will use his discretion as to taking samples to represent the fractions of above numbers. Each sample for chemical test will, however, represent a definite number of springs shipped, and the shipment will be accepted or rejected on this sample. The metal desired for springs is steel of the following composition: Carbon, 1.00 per cent.; phosphorus, not over 0.05 per cent.; silicon, not over 0.10 per cent.; manganese, 0.25 per cent.; and sulphur, not over 0.03 per cent. Springs will not be accepted which show on analysis less than 0.90 per cent. of carbon, or more than 0.50 per cent. of manganese.

It will be observed that the springs are divided into classes, according to the letters of the alphabet. The characteristic of each class and the mechanical engineering details will appear, it is hoped, later. At present the same kind of steel is used in all spiral springs, and this kind is specified in the description above. It is fair to state that for all springs in which the size of the bar is not over ½ in. in diameter, no chemical specifications are enforced, as it has been found by long experience that the kind of steel used is not an essential to their successful working. In other words, these springs are so designed that almost anything in the shape of steel will do the work required of them, and as their use is not enormous, it was deemed advisable not to enforce chemical specifications for this class of springs.

Turning now especially to the chemistry of the steel, it will be observed that the metal asked for is as good as in the case of the locomotive springs, but that the only requirements which are enforced are the carbon and manganese contents. This may seem a little strange, but we think the following explanation will make the matter clear.

Our position is that for steel where no physical test is possible, the chemistry of the steel shall be complete, and decides the quality. In cases where physical test is possible, and where a physical test can be made cheaper or with less difficulty than a chemical analysis, there use the physical test alone. In some cases the results desired can only be obtained by a combination of these, and this is the case with spiral springs. A physical test bringing the springs down solid is all the physical test that is practicable in the case of spiral springs, but this test does not show whether the elastic limit in the metal used is not just about reached when the springs are brought down solid, a state of affairs which is not desirable. In other words, it is fairly probable that a metal with 0.75 per cent. carbon pretty well tempered would have an elastic limit of about 80,000 lbs., so that if only a physical test of bringing the spring down solid was made use of, we might be getting springs in which the actual strain in the metal was up to the elastic limit of the metal, with no margin for extra strains introduced by the contingencies of the service. This point we think is thoroughly covered by the chemistry of the steel—namely, even an untempered steel of the carbon and manganese required by our specifications has an elastic limit pretty nearly or quite up to 80,000 lbs. But such a steel will not stand at the required height with a given load, and perchance would take a permanent set when brought down solid, therefore it is essential to temper it somewhat, which raises the elastic limit, and gives us the factor of safety required.

The query may arise why other substances besides the carbon and manganese are not determined. The reason for this is as follows: If a spring has the amount of carbon and manganese specified, and the phosphorus is high, with the amount of temper required in order to make it stand at the proper height with the specified load, or not take permanent set, that spring will break under physical test. In other words, the phosphorus, silicon, and sulphur are fairly well controlled by the physical test, provided the carbon and manganese are as specified. This was the reasoning made use of when the specifications were issued, and the experience of now some six or eight years seems to confirm the reasoning. In other words, if you control the carbon and manganese you can safely trust the physical test to protect you against receiving steel too high in the other objectionable constituents.

It will be observed that there is no upper limit to the carbon in steel for spiral springs, and the reason for this is that excessive carbon is likewise protected by the physical test. We do no work on these springs after they are received, and it is not essential that the carbon should be within certain limits. If the manufacturers are willing to put into these springs a steel containing 1.25 per cent. carbon, we are perfectly willing to receive them, provided they stand the physical test. The same reasoning in regard to the manganese applies in the case of this steel, as in the case of the steel for locomotive springs.

The working of these specifications has been in every sense satisfactory. The breakage of spiral springs in service has almost entirely disappeared. After some 30,000 of the bolster and draft springs had been put in service, a count was made to see how many of the springs, according to the new specifications, had been removed for breakage at one of the most important shops for car repairs, and less than five were found. Also it is fair to say that to one of the largest shops on the road some two years ago a request was sent to have every broken spiral spring, according to specifications, removed from freight cars, sent to the laboratory until 20 were found, and it took over a month to get this number.

There are still some problems not worked out in regard to spiral springs—namely, the question as to whether, under continued service, the springs will take a permanent set; and second, the question as to whether or not it is going to be essential to establish a limit of phosphorus, and indeed to go into the chemistry of the steel more completely than simply the carbon and the manganese. Upon the first of these two points it is fair to say that one considerable measurement of springs in service has been made, which resulted practically in showing that there was no appreciable permanent set to the springs which had been longest in service. Also recently the physical test has been made a little more severe—namely, all important springs are now brought down solid before they are sent from the works.

The question of phosphorus has been fairly well discussed in the early part of this paper, but arrangements have been made by which all springs which have been brought down solid under physical test and which broke or took a permanent set in service are to be sent to the laboratory until some more light is thrown on this subject.

As has already been stated, the breakage of spiral springs in service has very largely disappeared. Also it may be stated that the breakage of elliptical springs under cars is a very rare occurrence. The breakage of locomotive springs is more frequent, and recently an investigation has been started, to see if it was possible to locate the cause of the difficulty. There seem to be four possible reasons why a locomotive spring may break: *First*, bad steel; *second*, bad design; *third*, bad shop manipulation in the manufacture; and *fourth*, the use of springs designed for a certain track on very much rougher track.

Each of these items will bear a word. The question of the quality of the steel has been very carefully gone over

recently. Some 25 analyses of broken locomotive springs have been made. The result of this study shows that the steel in the locomotive springs which have broken is as good steel as we can get in the market, it having conformed to almost all the requirements given above for locomotive spring steel. We concluded from this work that the cause of the difficulty did not lay in the quality of the steel used. The second reason—namely, the design, is still under advisement, and it is possible some modifications of design may be necessary. This part of the study is not yet quite complete; but in view of the fact that the laws governing the use of metal in such structures as springs are pretty well worked out, it seems entirely possible to check up the design sufficiently well so that it will be safe to say that the difficulty is not with the design. If these two questions are satisfactorily settled, it would seem as though the difficulty with breakage must be either in the shop manipulation or in the fourth cause mentioned. Under the head of shop manipulation we refer to the danger of over-tempering or the over or under-heating of the steel, or other abuse of it by the blacksmiths making the springs. We have been accustomed to think that possibly considerable of the difficulty may lie here; but it has been recently suggested that there was a fourth cause—namely, the attempt to use a spring designed for a certain kind of track on a much rougher track. It should be stated that if the springs as designed are too strong, there is complaint that the engines ride roughly. On the other hand, if they are too weak as designed, so as to ride easier, and then are run at high speeds over a bad section of track, they receive shocks much more severe than they were designed to sustain, and consequently the leaves break. This point has not yet been fully worked out. All mechanical engineers are of course quite familiar with the fact that they are at all times in a strait betwixt two extremes, and that this applies to springs as well as to other parts of construction. To put it briefly, if the spring is designed to stand a rough track, it will ride very hard when it gets on smooth track, and where to draw the line is the great difficulty.

We hope to give the next article on bearing metal, and this will possibly be followed by one or two more.

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A COMPOUND ELEVATED LOCOMOTIVE.

THE accompanying illustration is from a photograph of a compound locomotive built by the Rhode Island Locomotive Works in Providence for the Brooklyn Elevated Railroad. As will be seen from the engraving, it is of the Forney type, with four drivers and a four-wheeled truck under the tank, which is carried on an extension of the frames.

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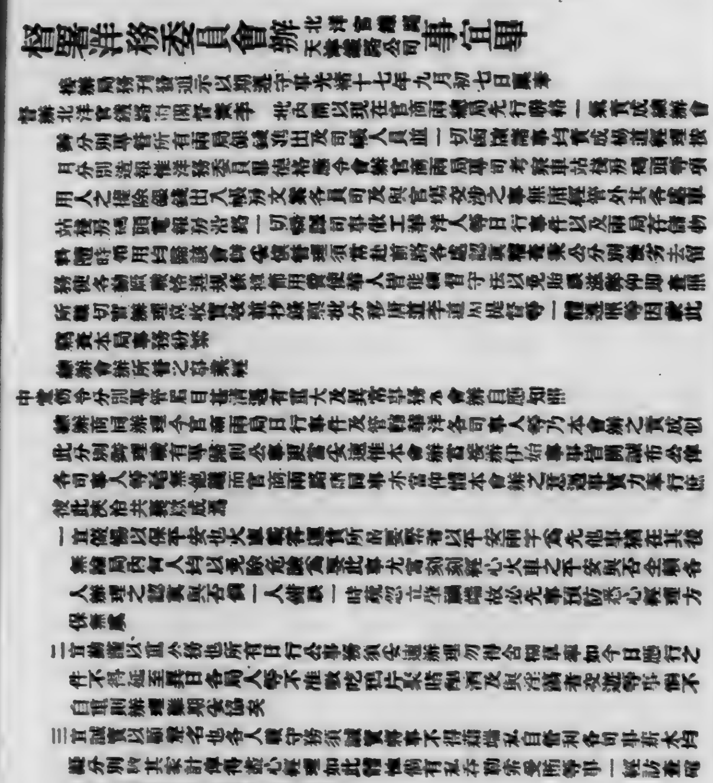

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Notification from the Assistant Managing Director on taking charge of the working staff of the Imperial Chinese Railway and China Railway Company.

MANAGING DIRECTOR'S OFFICE,
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To all employés of the Imperial Chinese Railway and China Railway Company:

On October 9, 1891, I had the honor to receive the following instructions from His Excellency, the Grand Secretary and Viceroy Li, Director-General of Imperial Railways:

"It is hereby ordered that the head offices of the Imperial Railway and the China Railway Company be now consolidated and placed under a Managing Director and an Assistant Managing Director, whose responsibilities shall be divided as follows:

"Receipts and disbursements of money, employés in the finance department, and Chinese official correspondence and accounts, to be in charge of Yang Taotai, who shall prepare monthly statements of the accounts.

"Mr. W. N. Pethick, of my Foreign Staff, is appointed Assistant Managing Director of both lines, with full charge of the working staff at the stations, storehouses, wharves, etc. He is not to be concerned with finances, finance staff, secretaries' staff or relations with Chinese officials. He is to have control over stations, godowns, wharves, telegraph offices, and all interpreters, assistants, and workmen, both native and foreign, in the ordinary course of business. All stores of materials for both lines and their issue as required shall likewise be in his charge. He will be required to frequently visit the stations, etc., and keep careful oversight of them; he is to act justly in employing or discharging people as they may deserve, and see that every employé faithfully performs his duties, obeys rules, and practices economy; and he is to be careful that native employés are properly trained and disciplined, so that mistakes and malpractices may be prevented.

"Let those concerned carry out these orders thoroughly, and so justify hope for substantial improvement in the service.

"Copies of this order will be sent to T'ang Taotai, Li Taotai, and General Chou for their guidance."

The respective functions of the Managing Director and the Assistant Managing Director are now clearly defined; and it will be my duty to report to the Managing Director any business of unusual importance.

My special responsibility is the entire control of the working staff and of the ordinary routine business of the whole line. This has been made by my superiors a separate department in order that one man may deal promptly with the numerous matters affecting the staff constantly requiring attention.

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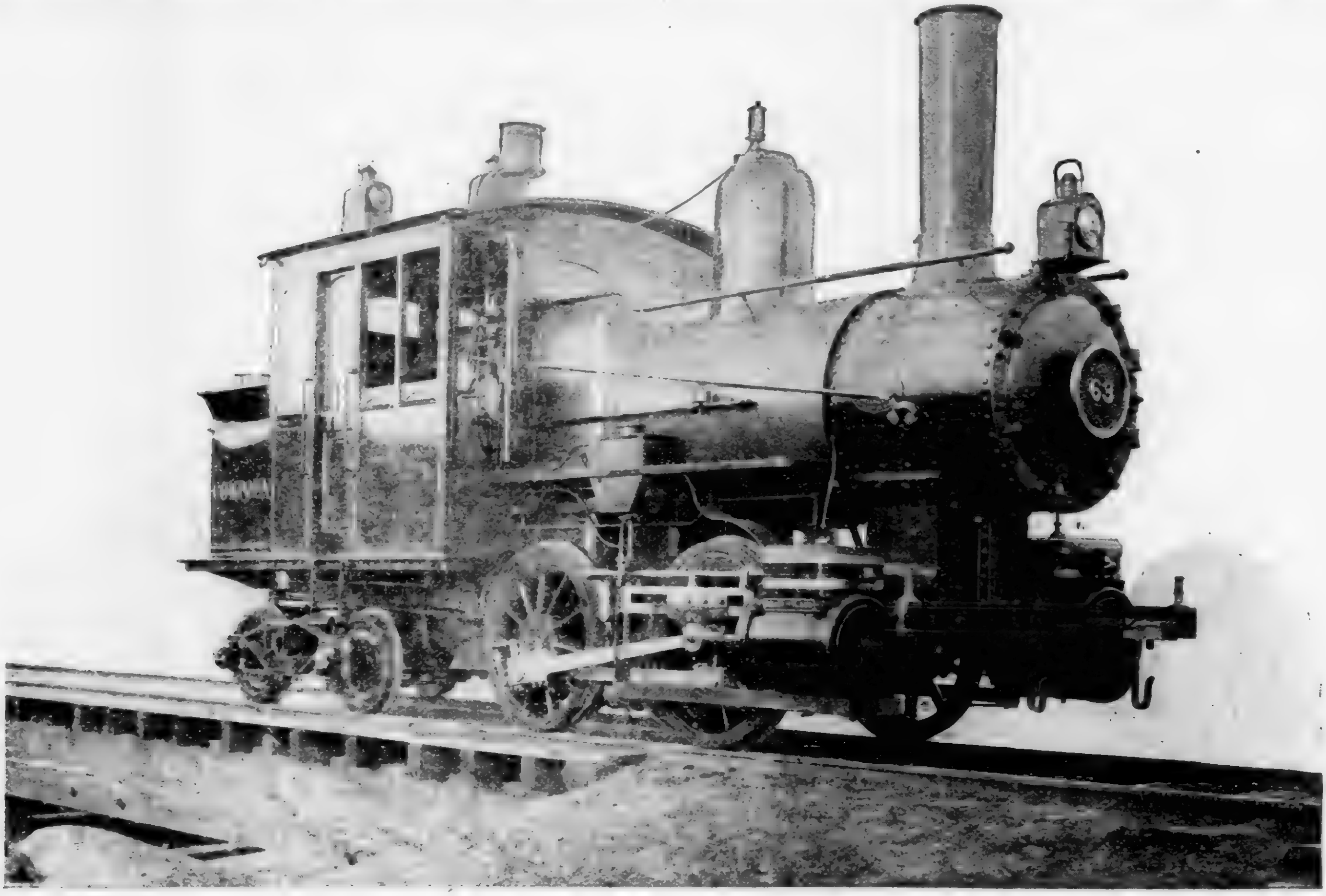

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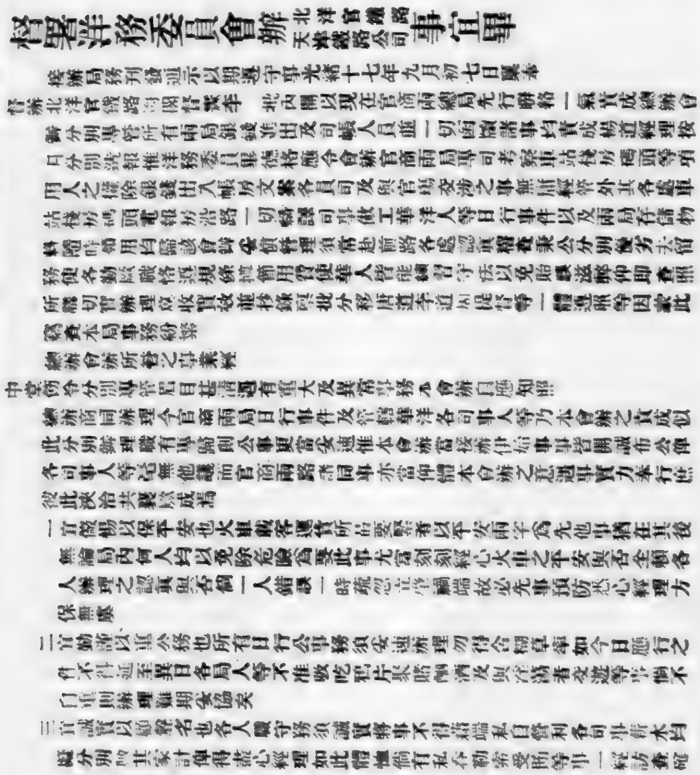

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passenger or shipper must be treated rudely or taken advantage of in any way. The railway is for the public convenience, and the good-will of the public will be obtained by courteous treatment.

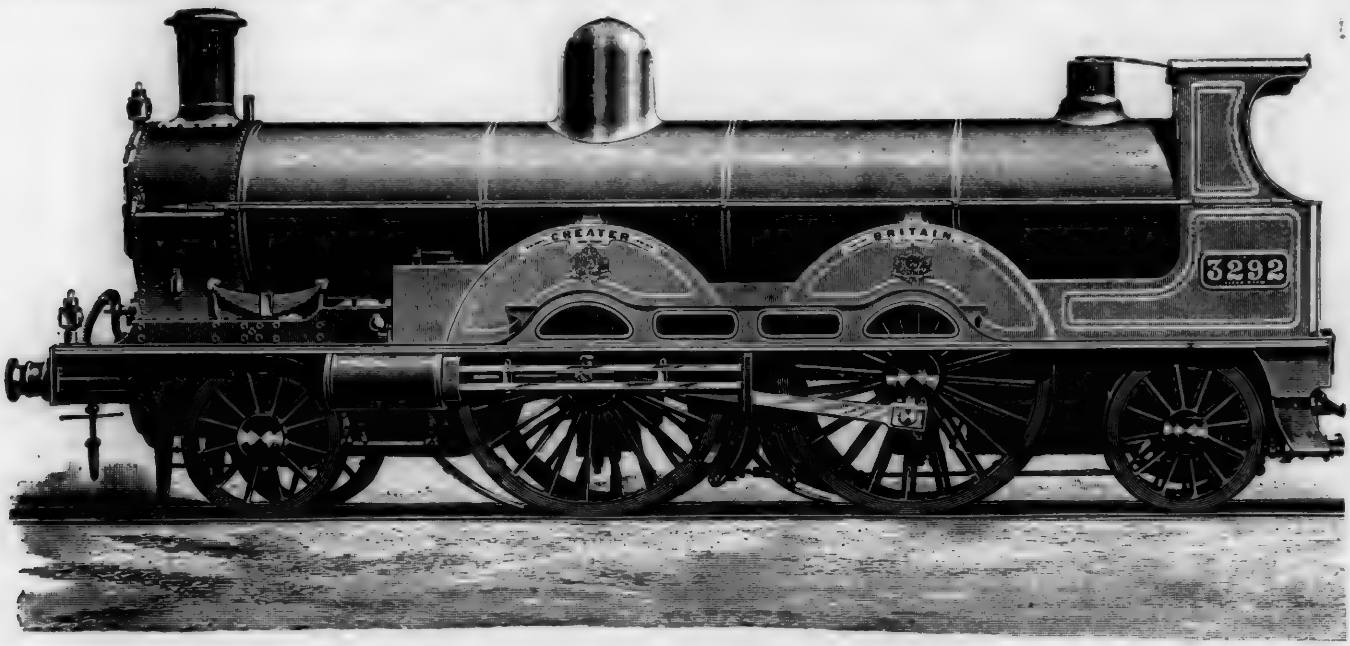
5. OBEDIENCE.—Orders and instructions given by those in authority must be obeyed promptly and fully. Disobedience of orders will not be excused in any one. This must be carefully remembered by all who wish to remain in the service.

I ask all employés, high or low, to give heed to these matters, and thus contribute to the success and good repute of the service. I shall take pains to know personally every member of the service, and how he performs his duties. I shall take pleasure in rewarding those who exert themselves, and will certainly dismiss or have otherwise punished those unworthy of confidence. Bad conduct or neglect of duty will not be overlooked. All should reflect that they are serving the country in an important new enterprise which will benefit Government and people if successful. If each does his duty success will be certain.

I would also ask you to remember at all times the importance of exercising courtesy and forbearance in dealing with the natives. There is often much to provoke or exasperate, but on no account should violence be used toward them, save only in defense of life. Nor should violent or abusive language be used. Adequate punishment for real offenses will be found in discharging or fining the offender, or suspending him from duty; and if more severe punishment is deserved, it can be administered in due form of law by the local official having jurisdiction. It is always possible to exercise firmness or do justice with show of violence. Nothing causes us loss of prestige more than a habit of giving way to angry passions.

Being in China, I do not expect to take part in any rapid transformation scenes. Reform and improvement will have to work their way gradually, but I hope none the less surely and thoroughly.

Mr. Pethick being an American and familiar with American methods, it is probable that they will be followed to a great extent in the management of the road, and in building its extensions, should any be undertaken hereafter.



COMPOUND EXPRESS LOCOMOTIVE, LONDON & NORTHWESTERN RAILWAY.

DESIGNED BY F. W. WEBB, LOCOMOTIVE SUPERINTENDENT.

In future instructions to the staff will be issued in the form of General Orders, printed in Chinese and English, and numbered consecutively. A copy will be sent to every employé concerned, and such orders must be carefully preserved and frequently read—no one who has disobeyed an order need then plead ignorance of it.

W. N. PETHICK,
Assistant Managing Director.

This order seems to be addressed chiefly to the Chinese employés, and is a sort of primary instruction or condensed elementary treatise on their duties. At the same time Mr. Pethick issued the following circular, which is especially addressed to the members of the foreign staff; the headings, etc., are omitted, giving only the substance of the order:

GENTLEMEN: Having been appointed by H. E. the Viceroy to the position of Assistant Managing Director, with control of the Working Staff and the ordinary business of both lines, I beg to inform you that I shall give special attention to measures for facilitating the prompt and efficient transaction of public business, and shall be glad to make such changes as may be for the good of the service.

To this end I trust that I may count on your co-operation. H. E., the Viceroy, having determined to give foreign management a fair trial, the duty devolves upon all of us to do what we can to justify this expression of confidence in foreign integrity and business methods; for it is the system more than the individual that will be on trial.

I particularly invite your attention to the first great essential of success—safety of life and property on the line. There are many factors in this problem; and I shall always be glad to receive and carefully consider practical suggestions bearing on any branch of the subject.

THE WEBB COMPOUND LOCOMOTIVE.

THE accompanying illustration, from *Industries*, shows the latest compound engine built by the London & Northwestern Company at its shops at Crewe. This engine is of the Webb three-cylinder type, having two high-pressure cylinders outside and connected to one pair of drivers, and a single low-pressure cylinder inside and connected to the other pair. There is no connection between the two pairs of drivers. As shown by the engraving, the driving wheels are all forward of the fire-box, and there are two pairs of bearing wheels, one behind the fire-box carried rigidly in the frames, and one pair forward having Mr. Webb's radial axle-boxes, which give a degree of flexibility approaching that of a two-wheeled truck.

The general plan of the engine made necessary the adoption of a very long boiler, and one of a peculiar type has been used. An intermediate combustion chamber is placed in the length of the barrel, having an opening at the bottom large enough for a man to get through, to which is attached a hopper for getting rid of any ashes which may accumulate in the chamber. To the bottom of this hopper is fixed a valve which is air-tight, and weighted in such a manner that in its normal position it will be closed. It is, however, connected to a rod leading to the

foot plate, so that it can be opened by the driver when necessary for letting out the ashes.

The barrel of the boiler is 51 in. in diameter and 18 ft. 6 in. long. The combustion chamber is 2 ft. 8½ in. long, and there are two sets of tubes, each set being 156 in number and 2⅛ in. in diameter. The rear tubes, extending from the fire-box to the combustion chamber, are 5 ft. 10 in. long, and the forward tubes, from the combustion chamber to the smoke-box, are 10 ft. 1 in. in length. The outside fire-box casing is 6 ft. 10 in. long. The grate area is 20.5 sq. ft. The heating surface is: Fire-box, 120.6; combustion chamber, 39.1; rear tubes, 493.0; forward tubes, 853.0; total, 1,505.7 sq. ft. The working pressure is 175 lbs. in ordinary service.

The leading and trailing wheels are of the same diameter, 49½ in.; the driving wheels are 7 ft. 1 in. The distance between leading axle and forward, or high-pressure, driving axle is 8 ft. 5 in.; the distance between driving axles is 8 ft. 3 in., and from rear, or low-pressure, driving axle to the trailing axle, 7 ft.; thus making the total wheel-base 23 ft. 8 in., and the rigid wheel-base 15 ft. 3 in. The driving axles have 8½ × 13½-in. journals, and the leading and trailing axles 6½ × 12-in. journals.

The weight of the engine in working order is 116,700 lbs., of which 28,670 lbs. are carried on the leading wheels; 34,720 lbs. on the forward drivers; 34,720 lbs. on the rear drivers, and 18,590 lbs. on the trailing wheels.

The frames are of the ordinary English plate type, the main frame being of 1-in. steel plate. The total length of frame is 32 ft. 5¼ in. over all.

The two high-pressure cylinders are each 15 in. in diameter and 24 in. stroke. The steam-ports are 11 × 1½ in. and the exhaust-ports 11 × 5 in. The valve-motion is of the ordinary curved link type; the valves are of the piston type, and have 4 in. maximum travel, $\frac{15}{16}$ in. outside lap and $\frac{3}{16}$ in. lead in full gear. There are four guides, with a cross-head of corresponding pattern, and the connecting rods are 8 ft. 3 in. long. The crank pins have 4 × 5-in. bearings.

The single low-pressure cylinder is 30 in. in diameter and 24 in. stroke. The steam-ports are 20 × 2¾-in. and the exhaust-port 20 × 5¼ in. The valve is worked by Mr. Webb's single-eccentric motion; it has 5½ in. travel and $1\frac{3}{16}$ in. outside lap. The connecting rod is 6 ft. 3 in. long; the bearing on the crank axle is 7¾ × 5½ in.

On its first trip after completion the *Greater Britain*, as this engine is named, was sent from Crewe to London, 157½ miles, with an experimental train, consisting of 23 six-wheeled passenger coaches. The weight of the train at starting was: Locomotive, 116,480 lbs.; tender, 56,000 lbs., cars, 684,260 lbs.; total, 856,840 lbs., carried on 82 axles. The ratio of the weight of train to that of engine and tender was 3.96 : 1. The length of the train was: Engine and tender, 54 ft.; cars, 880 ft.; total, 934 ft.

The time occupied in the trip was 4 hours, 2 minutes, including a stop of 21 minutes at Rugby. The average speed between Crewe and Rugby was 41.18 miles an hour; between Rugby and Euston Station, in London, 44.59 miles an hour. The particulars of the run are given as follows:

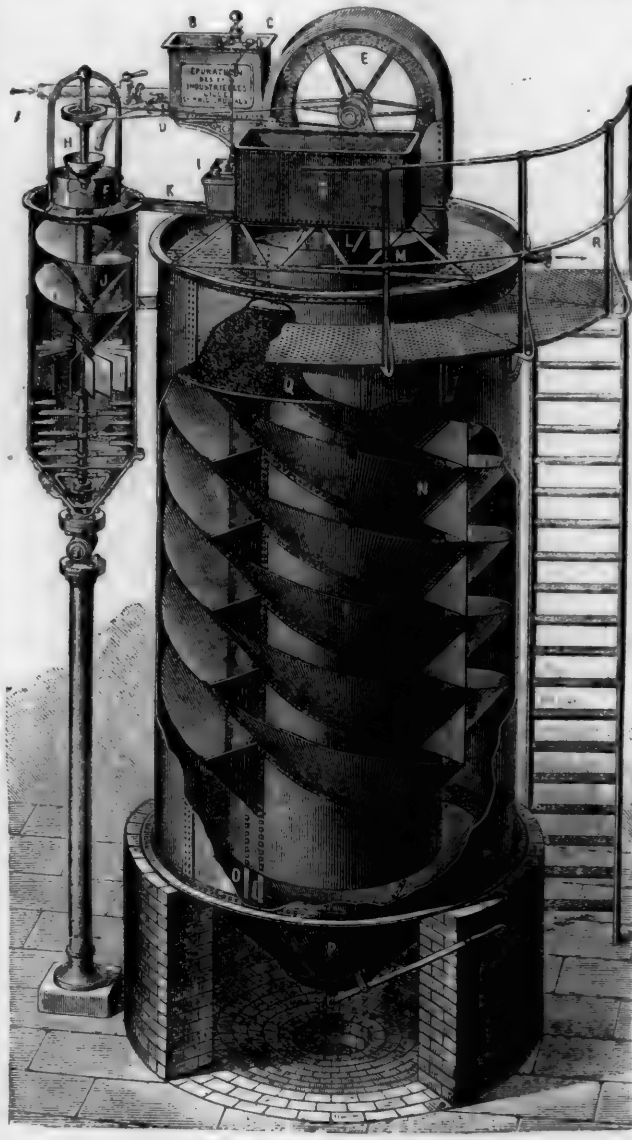
Stations.	Running Times.	Distance in Miles.	Speeds in Miles per Hour.	Weather.
Crewe..............dep.	11:04 A. M.			Fine.
Whitmore..........pass.	11:25 "	10½	30	"
Stafford.......... "	11:42 "	14	49.41	"
Rugeley.......... "	11:55 "	9¼	42.69	Strong
Lichfield.......... "	12:06 P. M.	8	43.63	side wind.
Tamworth.......... "	12:14 "	6¼	46.87	"
Nuneaton.......... "	12:33 "	13	41.05	"
Rugby..............arr.	12:54 "	14½	41.42	"
" ....dep.	1:15 "			
Blisworth..........pass.	1:46 "	19¾	38.22	"
Wolverton.......... "	2:00 "	10½	45	"
Bletchley.......... "	2:07 "	5¾	49.28	"
Leighton.......... "	2:15 "	6½	48.75	Rain.
Tring.......... "	2:28 "	8½	39.23	"
Watford.......... "	2:45 "	14¼	50.29	"
Willesden.......... "	2:58 "	12	55.38	"
Euston..............arr.	3:06 "	5¼	39.37	"

The results are computed by Mr. Webb as follows: The coal consumed on the journey was 34 lbs. per mile, or 0.089 lb. per ton of train per mile; the coal consumed, including 10 cwt. used for raising steam before starting, for the single journey from Crewe to Euston, was 41.1 lbs. per mile, or 0.107 lb. per ton of train per mile; if the usual double journey from Crewe to Euston and Euston to Crewe were run, the 10 cwt. for raising steam would be divided over the double trip, or 5 cwt. for raising steam, which would give a consumption of coal of 37.5 lbs. per mile, or 0.098 lb. per ton of train per mile. The tons here are, of course, the English ton of 2,240 lbs.

The total quantity of water evaporated on the journey was 5,896 galls., giving the high average of 10.96 lbs. of water evaporated per pound of coal consumed.

A NEW WATER PURIFIER.

THE accompanying illustration, from the *Revue Industrielle*, Paris, shows a new water-softening apparatus devised by M. H. Desrumaux, which is now being introduced by La Société Française pour l'Epuration des Eaux Industrielles, Lille, and which is reported to give excellent



A NEW WATER PURIFIER.

results. Like most of the modern forms of water-softening plant, it consists of two parts—(1) a tank in which the precipitation of the lime salts is effected, and (2) a special form of apparatus for removing the precipitate from the softened water. The preparation of the lime water, which is the reagent used to bring about the precipitation, is also effected in a special form of mixing plant which produces lime water of the maximum strength.

The water to be softened enters the apparatus at A, and passes into the small regulating tank B, which ensures a constant level, and which distributes such a proportion of the water to the lime in the accessory cylinder J as to form sufficient reagent to effect the complete softening of the water, while the remainder and greater portion of the water passes at once into the interior of the precipitation cylinder at L. A determination of the hardness of the water indicates the relative distribution of water to the two parts of the apparatus, and, when once regulated, will work without any further attention so long as the charge of lime is unused.

The preparation of the lime water is effected as follows: The tank F, with a perforated bottom, is filled with lime, and the adjusted quantity of water flows on to this from the tap D. Below the charge of lime at J is a concentric helix and paddle, which is set in motion by the revolution of the wheel E, which is itself moved by the flow of water into the precipitation cylinder. The revolution of the helix below the lime tank ensures a complete saturation of the water with lime, and thus allows a lime solution of constant strength to pass from the apparatus by the conduit F into the precipitation plant. G is a reservoir containing soda solution, and it is regulated by the float I, which is connected with the tank B. The mixed waters first pass down the central cylinder M, and then ascend the spiral of the external concentric cylinder. This spiral is fitted with diaphragms at frequent intervals, which, while arresting the passage of the precipitated carbonate of lime, do not hinder the ascending water, which finally passes through the filter Q and arrives at the top of the apparatus clear and bright, and passes away through the tube R. The precipitate is removed from time to time by opening the precipitation cylinder at the base P, and the lime tank F is recharged from day to day. La Société Industrielle du Nord (France) recently appointed a committee to examine the working of this plant in that district, and in the report the satisfactory use of these softeners is recorded.

THE PROPOSED TOWER AT CHICAGO.

THE accompanying illustrations show in outline the design prepared by Mr. George S. Morison for a great tower 1,120 ft. high, to be erected in connection with the Columbian Exposition in Chicago. In the drawings fig. 1 is an elevation; fig. 2, a base plan; fig. 3, a plan of the first platform; fig. 4, a skeleton, showing the general arrangement of the work. The whole design is very fully described below by the Engineer himself:

GENERAL DESCRIPTION.

The general arrangement of the tower and the arrangement of the accommodations are modeled from those of the Eiffel Tower at Paris.

The base of the tower is made approximately two-fifths of the height; 200 ft. above the base is placed the first platform, which is to be occupied by promenades, restaurants and miscellaneous accommodations; the level of this is high enough to command the best view of the entire Exposition grounds and buildings. The second platform is placed 200 ft. higher up than the first, though it will not be of so much importance, and 500 ft. higher up is the lantern, which is the principal point for distant views, and is surmounted by a light-house and flag-staff, the whole having a height of 165 ft.

While, however, the general arrangement is derived from that of the Eiffel Tower, the system of construction is necessarily of a very different character. The problem to be solved was to design a tower to be carried on the soft soil on which the city of Chicago is built, this soil being a fine sand which carries large weights perfectly well when they are properly distributed or supported, but has little power in itself to resist lateral thrusts. This rendered anything like the inclined supports of the Paris Tower inadmissible, and further, made it necessary to provide for the expansion of the metal of the tower in a manner which would not strain the foundations.

Besides these considerations of foundations, it was also necessary to design a tower which could be built in the shortest possible time and erected with a maximum speed. This made it necessary to confine the construction to right lines and square angles, and led to the selection of the plan adopted.

The upper shaft from the lantern down to the second platform is a square shaft battering from 40 ft. square at

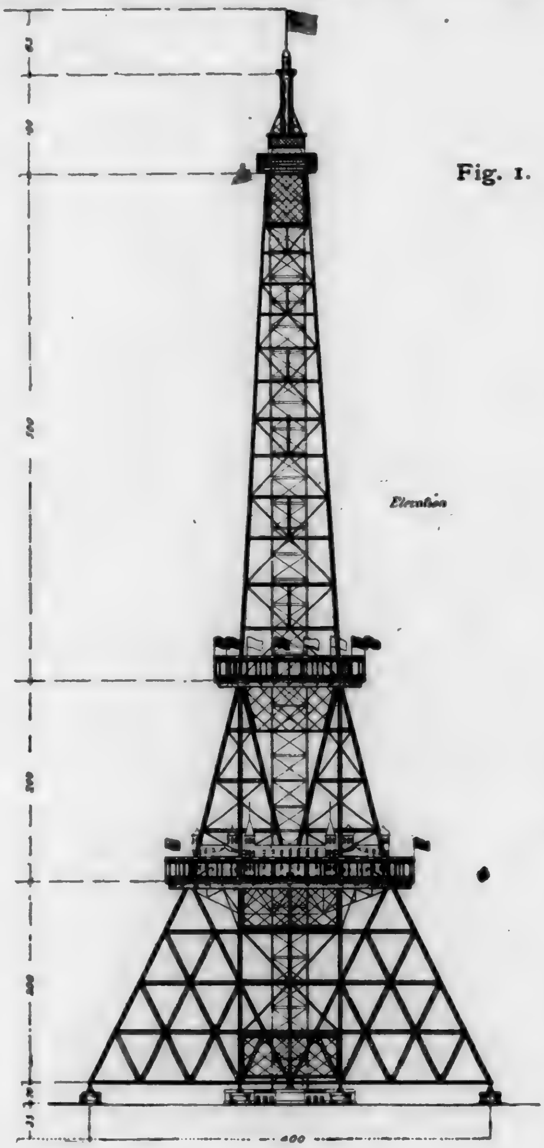


Fig. 1.

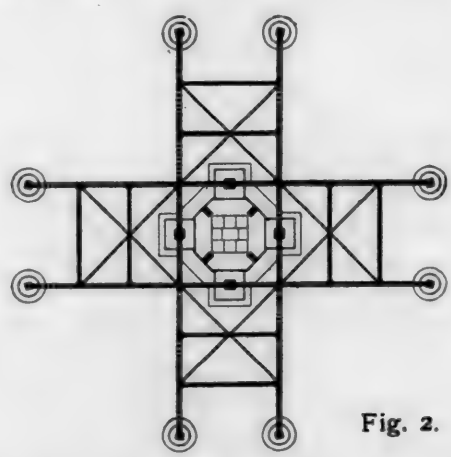
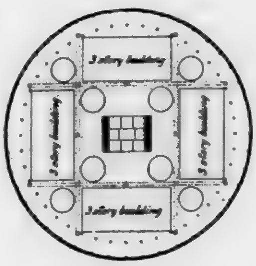


Fig. 2.

the top to 100 ft. square at the base, the entire weight being carried by the four corner posts, which are stiffened by bracing in each of the four planes. The details are of

much the same character as those of the high towers of an iron viaduct. It is the simplest possible form of construction as well as the strongest and most easily erected.

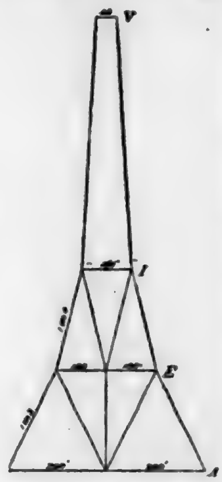
From the second platform to the first each of the four sides of the upper shaft is continued downward in a vertical plane, the four planes intersecting each other on vertical lines 100 ft. apart. Each of the four corner posts is therefore over one of the intersection lines of the planes, and the weight from each of the corner posts is distributed on four posts, two in each plane, these posts battering from each other with an inclination of one in four. The section of the tower, therefore, between the first and second platform consists of 16 posts, of which four are in each of the four planes, the interior posts coming together at the base, and the arrangement of the four posts being like an inverted W, 300 ft. high and 300 ft. wide. The shape, therefore, of the tower at the level of the first platform is cruciform, measuring 300 ft. in each direction and



First Platform

Fig. 3.

Fig. 4.



100 ft. across each arm. The posts are braced together at intervals of 50 ft. in the four planes.

Below the first platform the weight from the eight interior posts is carried directly to the foundation by vertical posts, while the weight from the exterior posts is carried down on the same principle that the weight from the four posts of the upper shaft is carried—that is, by two equally inclined posts from each point. To bring these posts together at the center it was necessary to double the batter, making it one in two, instead of one in four. Each plane, therefore, of the lower 200 ft. of the tower becomes an inverted W, 200 ft. high and 400 ft. wide on the base, with a vertical member in the center. The members of this plane are stiffened by bracing placed every 50 ft. The base of the tower is then of cruciform section, each arm being 400 ft. long and 100 ft. wide.

The weights of the lantern and the several platforms are provided for at their several levels.

With this arrangement more than half the total weight of the tower is carried on four central points and is a fixed quantity. The remainder is carried on eight outlying piers and varies with the wind pressure. The live load is distributed in the same way, but of course is variable everywhere. The four central points of support are made fixed points and rest on piers which are united into one great foundation. The bearings on the outlying points are all made with expansion links which are able to resist both tension and compression, and the lines of motion of these links are made radial to the center of the tower, so that the expansion of the metal, both longitudinally and transversely, is provided for at the same time. The only expansion not provided for is that due to different temperatures in different parts of the lower horizontal plane, which is so small that it may be neglected. The entire structure is tied across the base and is complete in itself, the only stress transferred to the foundations being a vertical pressure.

The maximum weight thrown by the tower with a complete estimated live load on each of the four central points is 1,760 tons, or in round numbers 7,000 tons on the whole foundation, and the maximum weight thrown on each of the eight outlying piers is 880 tons, this, however, being largely due to wind; the dead load alone thrown upon each of these piers is less than 300 tons.

If these weights are compared with the weights on the foundations of many of the tall buildings in Chicago, and especially under the grain elevators, which are the heaviest and oldest structures in the city, it will be seen that, in spite of the immense size of the tower, the foundations are a comparatively simple thing.

The weight of the structural portions of the tower above the masonry foundations is about 7,000 tons. To this is to be added 2,000 tons for the weights of floors and buildings, and 2,000 tons more for live load, making a total weight of 11,000 tons, of which less than one-fifth is variable.

A grain elevator of 1,000,000 bushels capacity—and there are much larger elevators than this in Chicago—weighs when full of grain at least 50,000 tons, of which more than one-half is variable, besides which it exposes a large flat surface to the wind, and in all respects is subject to much greater disturbing elements than the tower.

ACCOMMODATIONS.

The accommodations, though following the same general arrangement, have been materially increased from those of the Eiffel Tower.

The first platform, fig. 3, which is supported on a cruciform section, is made circular, this shape being easily adapted to the shape of the support. The platform is 250 ft. in diameter. Around this platform runs a covered colonnade 15 ft. wide, the roof being supported by two lines of columns, and a substantial fence being placed between the columns of the exterior row. This forms a continuous promenade unbroken by angles or any local features to check the movements of a crowd. Inside of the circular promenade the platform is left uncovered, except where occupied by buildings. The spaces between the colonnade and the planes in which the structural members are give room for four large buildings 45 ft. wide and 90 ft. long. These buildings will be of light construction and three stories high, and will be occupied as restaurants; the lower stories will be only 7 ft. high and used as serving rooms; the second and third stories will each be 15 ft. high, and these, together with the flat roof, will furnish accommodations for chairs and tables; from each of these floors there will be an uninterrupted view, people on the first floor looking over those walking on the promenade; people on the second floor looking under the roof of the colonnade, and those on the roof looking over the roof of the colonnade. In the interior, besides the space occupied by the four large buildings, there will be room for a number of small buildings to be occupied by various small booths and other buildings.

The lantern will be supported on the four corner columns, which are 40 ft. apart, the length of the diagonal being therefore about 57 ft. The lantern is made 60 ft. in diameter and two stories high, each story, however, to be but 7½ ft. high. This will give two rooms, each having a circumference of 188 ft., which would be the lookouts of the tower, thus giving nearly 400 ft. of observation wall. The circular outside wall of each floor would be made solid for a height of about 3 ft. from the ground; the next 3½ ft. will be of plate glass, and above this will be a frieze, which will be graduated to mark the points of the compass, and the names of important places can be painted in the proper directions; this circle will be of such size that each degree will be more than 6 in. long. Above the two observation halls will be an open gallery to which the public will not be admitted, but on which a small circular railroad can be laid on which a powerful electric light can travel so as to make variable effects of colored light, while within this track will be a smaller building containing rooms for special purposes. Above this small building a round shaft made of boiler plate 12 ft. in diameter will extend 60 ft.; this shaft will contain a spiral staircase leading to the highest platform of the tower, 1,020 ft. above the graded surface of the ground. Above this platform will be a lighthouse surmounted by a flag-staff, the total height from the ground to the top of the flag-staff being 1,086 ft., and from the bottom of the foundation to the top of the flag-staff 1,120 ft.

Within the main structure is to be built a secondary structure 36 ft. square and of uniform size throughout, extending from the foundation to the lantern. This structure is to hold the elevators. It is divided into nine shafts of approximately equal size, eight of which will be occupied by the elevator cars, and the ninth at the center will hold the machinery. Each elevator car will have an area of 100 square feet and be capable of carrying 50 people. The four corner cars will run to the first platform; two of the others will run to the second platform, stopping at the first; the other two will run to the top of the tower. There will be separate entrances at the base to the three different classes of cars, so that no confusion can result.

A double staircase will be built around the elevator shafts from the foundation to the first platform, and a single staircase from the first to the second platform.

CONSTRUCTION.

FOUNDATIONS.—The foundation work will comprise eight outlying piers supporting the exterior bearings of the tower, and the central pier, which supports the center bearing. The general principle adopted for these foundations is that of concrete piers resting on piles. The weight per pile will be limited to from 10 to 15 tons, according to observations to be made when work is actually begun. These weights are without any allowance for the bearing on the ground surface between the piles; if the piles were entirely omitted the weight on the surface would be from 1¼ to 1¾ tons per square foot.

The concrete foundation will begin 2 ft. below mean water in Lake Michigan, and the piles would extend up three feet into the matrix of concrete. All concrete will be first class Portland cement concrete. The central pier will contain 7,500 yards of concrete and be supported on 1,600 piles. Each of the outlying piers will contain 700 cubic yards of concrete and be supported by 185 piles.

Above the concrete foundation, which will be about level with the graded surface of the ground, will be built separate piers, one on each of the outlying foundations and four on the central foundation. These piers will be of limestone with heartings of Portland cement concrete, the piers on the central foundation being 30 ft. square and 14 ft. high, and those on each of the outlying foundations 20 ft. in diameter and 11 ft. high. The total amount of masonry and concrete in all the foundations is somewhat more than 15,000 cubic yards.

STRUCTURAL METAL.—The tower will be built of mild steel and of wrought iron; wrought iron being used only in the lighter members. The principal columns are of square box section, fitted with man-holes and interior ladders for purposes of inspection and convenience of workmen. These columns below the second platform will be 40 in. square, and above the second platform they will taper, decreasing from 40 in. at the base to 16 in. at the lantern. All the interior columns will be built of plates and angles with open laced sides. All bracing and stiffening members will have riveted connections, so that nothing can get loose; the compression members are generally square, made of four angles at the corners and with all four sides laced; the tension members are made of four bulb angles placed in pairs, back to back, with a single line of lacing.

The weights on all the floors are taken at 100 lbs. per square foot, of which one-half is treated as live load. The weights of the tower used in the calculations are the actual weights of the metal. A wind pressure of 50 lbs. per square foot on the entire structure is provided for, and a wind pressure of 80 lbs. per square foot on the lantern is provided for in all members above the second platform.

With these conditions the strains are limited to 14,000 lbs. per square inch on square box columns, within a maximum unsupported length of 16 times the width, and these strains are reduced for longer columns, or when thin metal is used in the plates. Where any member is subject to both tension and compression, the sum of the two strains is used in determining the section.

The interior elevator shaft will be of the same character of material and will rest directly on the central foundation.

The entire structure will be incombustible, the floors of the platforms being covered with asphalt or cement concrete, and no wood being used anywhere for structural purposes.

CLASSIFICATION OF PIECE-WORK ON LOCOMOTIVES.

THE subject of piece-work in locomotive and railroad shops has been much discussed, and in many shops the system has been more or less completely adopted, usually with very good results. Its use is extending; and as the arrangement and classification of the work requires care and consideration, we believe that the classification given below will be of interest to many.

This classification is that which has been adopted for the shops of a leading railroad, in which new construction as well as repair work is done, and is for an eight-wheel passenger locomotive. In use it is made out in table form, like the specimen given below:

FOUR-WHEEL ENGINE TRUCK.

Pieces.	Per piece.	Per pair.	Price.	Remarks.
Boring center casting.......				
Planing " "				
Drilling " "				
Boring wheel center				
Turning " "				
Planing pedestal				

In giving the classification below, it has been thought unnecessary to continue the table form throughout, the main object being to show the items into which the work is divided. This is well indicated by the list given, which is also interesting as giving an idea of the number of pieces which go to make up a complete locomotive, and the variety of work which has to be done upon them.

FOUR-WHEEL ENGINE TRUCK.

Molding Center Casting.
" Wheel Center.
" Pedestal.
" Journal Boxes.
" " " Cellars.
" Axle Collar.
" Liners.
" Spring Seat.
" Sponge Cup.
" " " Cover.
" Journal Bearings.

Forging Side Frames.
" Axles.
" Equalizers.
" Pedestal Braces.
" Cross Braces.
" Spring Hangers.
" " " Pins.
" " " " Thimbles.
" Truck Springs.
Rolling Steel Tires.

Boring Center Casting.
Planing " "
Drilling " "
Boring Wheel Center.
Turning " "
Planing Pedestal.
Slotting "
Drilling "
Planing Journal Boxes.
Slotting " "
Drilling " "
Planing " " Cellars.
Boring " " "
Drilling " " "
Boring Axle Collars.
Drilling " "

Turning Sponge Cup.
Drilling and Fitting Sponge Cup.
Planing Journal Bearings.
Babbitting " "
Drilling and Fitting Journal Bearings.
Planing Side Frames.
Slotting " "
Drilling " "
Cutting off Axles.
Turning Axles.
Fitting Axles into Wheel Center.
Slotting Equalizer.
Drilling "
Planing Pedestal Braces.
Drilling " "
Planing Cross Braces.
Drilling " "
" Spring Hanger.
Turning " " Pin.
Drilling " " "
Boring Steel Tires.
Shrinking " "
Building Truck (Complete).

ENGINE FRAMES.

Pedestal Blocked at furnace.
" Trimmed at forge.
Back End Frame at furnace.
" Brace Frame at furnace.
Front Brace Frame at furnace.
Welding Frame.
Frame Tongue at furnace.
" " " forge.
Intermediate Brace at forge.
Pedestal " " "
" Collar Bolt at forge.
" Wedge " " "
" " " Guard at forge.
Frame and Boiler Brace " "
Throat Brace at forge.
Frame Brace 1¼ × 5½ at forge.
" " 1¼ × 3 " "
Boiler Liner at forge.
Tail Brace Top at forge.
" " Bottom at forge.
Friction Wedge at forge.
Frame Clamp 9 × ¾ at forge.
" " 8 × ⅝ " "

Molding Step under Tail Brace.
" Pedestal Shoe.
" " Wedge.
" Friction Casting.
Planing Frames.
Slotting "
Fitting up Frames.
Setting " "
Drilling and Applying Clamps.
Planing Frame Tongue.
Slotting " "
Planing Intermediate Brace.
Slotting " "
Planing Pedestal Brace.
Slotting " "
Planing Tail Brace.
Slotting " "
Planing Friction Casting.
Drilling " "
Planing " Wedge.
Drilling " "
Planing Boiler and Frame Brace.
" Throat Brace.
" Frame " 1¼ × 5½.
" " " 1¼ × 3.
" Pedestal Shoe.
Drilling " "
Tapping " "
Planing " Wedge.
Drilling Steps.
Tapping "

CYLINDERS.

Making Cylinder Cores.
" " Head Cores.
" " " Casing Core.
Molding Cylinder.
" Front Cylinder Head.
" Back " "
" Front " Casing.
" Back " "
" Center Casting.

Turning " "
Boring " "
Drilling " "
Boring Cylinder.
Planing "
Milling "
Drilling "
Tapping " for Studs.
Grinding " " Back Heads.
Chipping and Fitting for Smoke Box.
Drilling for Bolts.
Mounting Cylinders and Fastening to Frames.
Fitting Studs in Cylinders.
Turning Front Cylinder Head.
" Back " "
Boring " " "
Drilling " " "
Turning Front Cylinder Casing.
" and Boring Back Cylinder Casing.
Working Cylinder Lagging.
Putting on Cylinder Lagging.
Making Cylinder Casing.
Putting on Cylinder Casing.
Making and Putting on Copper Joint.

CYLINDER COCKS.

Molding Cylinder Cock.
" Handle for Cylinder Rods.

Forging Set of Cylinder Cock Rigging.

Turning Cylinder Cock.
" " " Valve.
" " " Shaft.
" " " Arm.
" " " Pins.
Fitting up Cylinder Rigging Complete.

STEAM CHEST.

Molding Steam Chest.
" " " Cover.
" " " Casing.
" " " " Cover.
" " " Gland.
" Slide Valve.
" Balance Plate.
" Side Strips.

Forging Valve Yoke.
" " Stem (socket) End.
" " " (boss) End.

Planing Steam Chest.
Boring " "
Planing " " Cover.
Drilling " " "
" and Tapping Steam Chest for Relief Valve.
Planing Valve.
" " Strips.
Fitting up Valve.
Turning Valve Yoke.
Planing " "
Slotting " "
Fitting up Valve Yoke.
" Key in Valve Stem.
Turning Front End Valve Stem.
" Back " " "
" Valve Stem after Welding.
Making and Putting on Copper Joint.
Fitting up Steam Chest and Covers.
" on Casing and Lids.

PISTON.

Molding Piston Head.
" Packing Hulls.
" Piston Gland.
" Brass Nut.
" Bushings.

Forging Piston Rod.

Turning Piston Head.
" and Cutting Thread in Nut.
" Gland.
" Piston Rod.
Cutting Key-way in Piston Rod.
Fitting Rod to Cross Head.
" in Piston Key.

GUIDES.

Molding Top Guide.
" Bottom Guide.
" Guide Oil Cup.

Forging Guide Yoke Brace.
" " Blocks.
" " Bolts.

Planing Guide Yoke.
Slotting " "
Boring " "
Drilling " "
Setting " "
Planing "
Slotting "
Drilling "
Planing " Blocks.
Turning " "
Drilling " "
Milling " "
Turning " Block Washer.
Fitting in Guide Block Key.
Turning Oil Cup.
Fitting up Guides.

CROSS-HEAD.

Molding Cross Head.
Forging " " Key.
" Steel Set Screw.

Boring Cross Head.
Planing " "
Slotting " "
Turning " "
Drilling " "
Babbitting " "
Fitting up " "

ROCKER.

Molding Rocker Box, Right.
" " " Left.
" "

Forging Rocker Pin.

Planing Rocker Box.
Drilling " "
Boring " "
Planing " " to fit Frame.
Laying off " "
Fitting " "
Turning "
Fitting "
Boring "

LIFTING SHAFT.

Molding Lifting Shaft Stand.

Forging " " Solid.

Turning " "
Drilling " "
Fitting " "
Planing " " Stand.
Boring " " "
Drilling " " "

VOLUTE SPRING.

Forging Volute Spring.
" " " Rod.
Fitting up " "

LINKS.

Molding Link Die.
" " Block.

Forging Links.
" Hanger.
" Link Saddle.
" Die Pin.
" Link Hanger Pin.

Planing Link.
" Die.
" Block.
Drilling Link.
Fitting Links together.
Radiusing Links.
Boring out Die.
Drilling "
Planing Saddle.
Drilling "
Planing Die Block.
Drilling Links.
Fitting Bolts.
Turning Hanger.
Drilling "
Slotting "
Fitting up Links, and all Connections.

ECCENTRIC.

Molding Eccentric.
" " Strap.
" " Oil Cup.

Forging Eccentric Hook, Foot.
" " " Jaw.
" " " Center Piece.
" " Bolts.
" " Hook Jaw Bolts.
" " " Feet Bolts.
Welding " " and Jaw.

Planing Eccentric.
Drilling "
Fitting "
Boring and Turning Eccentric.
Slotting Eccentric.
Fitting in Set Screws.
Planing Eccentric Strap.
Drilling " "
Fitting " "
Turning " "
Planing " Hook Jaw
Slotting " " "
Drilling " " "
Planing " " Feet.
Drilling " " "
Slotting " " "
Turning " Oil Cup.

REVERSE BAR.

Forging Lead Bar Ends.
" Reverse Bar Rigging.
" " " Trigger.
" " " Strap.
" " " Rack.
" " " Brackets.
Welding " "

Molding " " Stand.
" " " Bushing.
" " " Handle.

Slotting Lead Bar Ends.
Planing " " "
Drilling " " "
Turning Reverse Bar Ends.
Slotting " " "

Planing Reverse Bar Trigger
" " " Rack.
" " " Clamp.
Fitting up Reverse Bar.

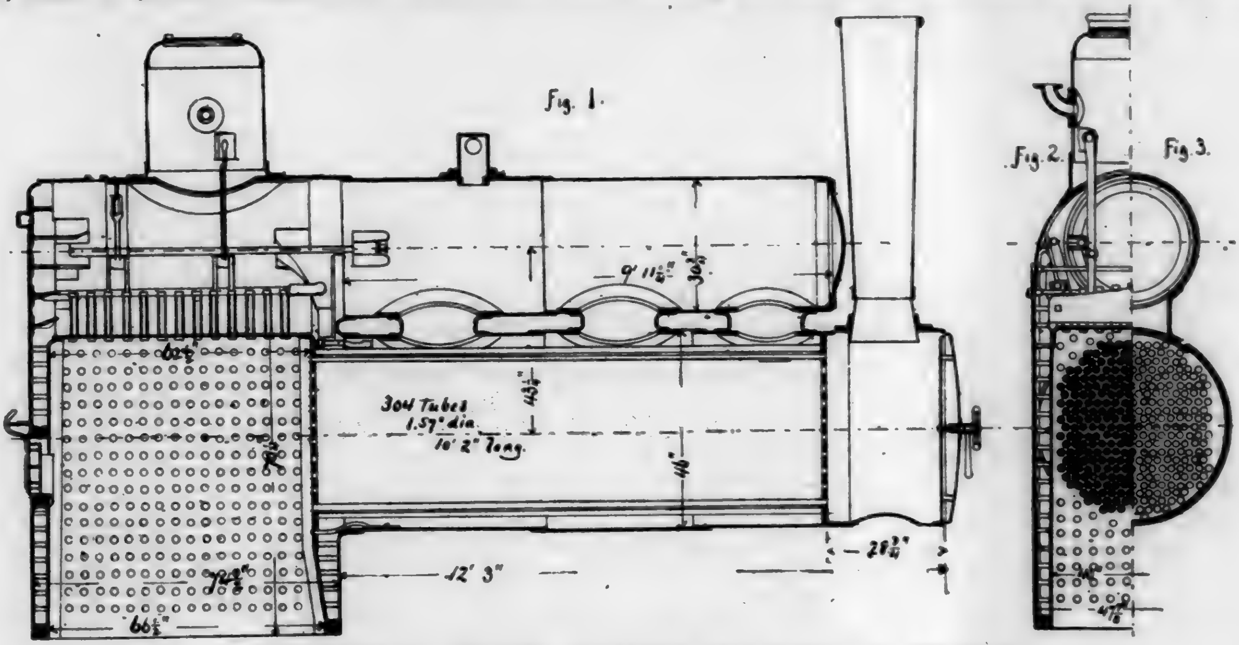
It will be seen that this classification is a very complete one, including the work of all descriptions. It will be continued in the next number.

(TO BE CONTINUED.)

AN EXPERIMENTAL LOCOMOTIVE BOILER.

THE sketches given herewith show an experimental locomotive boiler built by the Eastern Railroad of France, from the design of M. Flamand, Consulting Engineer of the company. Fig. 1 is a longitudinal section; fig. 2 a half cross-section through the fire-box, and fig. 3 a half section through the barrel.

As will be seen from the drawings, the barrel of the boiler, which is 46 in. in diameter, is entirely filled with



EXPERIMENTAL BOILER, EASTERN RAILROAD OF FRANCE.

tubes; there are 304 in all, 1.57 in. in diameter and 10 ft. 2 in. long. The upper barrel or steam-drum is connected with the outer fire-box casing at the rear end and has also three connections with the main barrel; it is 30⅜ in. in diameter and 9 ft. 11¼ in. long. The usual water level is just below the center-line of this upper barrel.

It is claimed that this form of boiler, taking all its heat from the fire-box and tubes directly, will utilize a larger proportion of the heat than the ordinary locomotive type, and will not require any form of superheater or return tubes.

The boiler shown was built for an old locomotive of the Crampton pattern—which still finds some favor in France—and was worked at a service pressure of 145 lbs. It has been in use about 18 months, and the results obtained have been so good that the company is now building 12 boilers of the same pattern for new locomotives.

NOTES ON COMBUSTION.

BY C. CHOMIENNE, ENGINEER.

(*Continued from page* 549, *Vol. LXV.*)

RECAPITULATION.

THE use of an anemometer with each fire-box will enable us to determine the draft at each moment of the combustion, and to ascertain at the same time the precise quantity of air needed to obtain the maximum useful effect with different varieties of coal.

Frequent analyses by the Orsat apparatus of the gases which escape into the chimney will permit us to ascertain whether all the air has been properly employed in burning the coal.

Heretofore only natural draft has been used with chimneys of a height varying from 30 m. to 40 m. A chimney of 30 m. is sufficient to produce a draft of 0.016 to 0.018 m. with gases, the temperature of which varies from 200° to 230° C. To obtain a stronger draft, it is necessary to increase the height considerably. Thus a chimney of 45 m. gives only a draft of 0.025, and the capacity with an equal section is only one-sixth greater than that of a chimney of 30 m. This shows that it is better to increase the section than the height, the capacity increasing proportionally to the square of the diameter. We should only resort to an increase of height in those cases where high ground or a neighboring high building forces us to do so in order to prevent injury to the draft. With stationary boilers nothing has been said of the forced draft which is used on railroads and with marine boilers. This forced draft serves to increase the activity of combustion, but is not economical because the gases escape at a very high temperature in consequence of the rapidity with which they are forced through the boiler, and which prevents them from giving up a sufficient proportion of their heat.

In locomotive boilers, for instance, where the draft corresponds to 0.025 to 0.075, the temperature of the gases in the smoke-box varies from 290° to 350° C. for boilers of the ordinary size, which indicates a loss of between 12 and 14 per cent.

As to blowers, either steam or air, they have the fatal effects of introducing complication in the firing and of consuming steam in such quantity that so far none of them have given the economical results hoped for. It is the case with these blowers that they have produced a mixture of gases which tends to facilitate combustion, but at the same time the gases are cooled, which tends to arrest the combustion; and it is because of this contradiction that few of them have given good results.

To sum up: if we wish to save considerable quantities of coal, it can only be done by removing from the boiler the other causes of incomplete combustion which are much more considerable than those resulting from the waste through the smoke. At the same time we should not neglect the advantages of consuming this smoke.

We must never forget that the result obtained from a boiler varies according to the quality of coal, the form of the apparatus, and lastly the experience and capacity of the firemen. From careful experiments made in Alsace and in Belgium, it was pretty well shown that the type of

boiler has not the excessive importance which has been sometimes attached to it. To obtain a good result, it is not wise to require an excessive amount of work from the boilers. The principal point is to have a proper proportion of heating surface, and it is the selection of this proportion which constitutes the chief point of merit in a steam generator.

For a manufacturing establishment other points must be taken into account, including the price or cost of setting, ease in cleaning and repairs ; these things are often forgotten or not sufficiently considered. For large boilers in manufacturing establishments the combustion which has given the best results is generally included between 1 kg. and 1.5 kg. of carbon per square meter of heating surface per hour, and the ratio between the grate area and the heating surface should be about 1 : 50.

In firing the stirring up and cleaning of the fire should be done at the proper time. The passages to the chimney and the outside of the boiler should be cleaned frequently, as a rule not less than twice a month. A loss in efficiency will be noticed at once if the exposed surfaces are left to be covered by soot and cinders. The quantity of this deposit depends largely upon the quality of the coal, and strong draft will increase the amount. In semi-tubular boilers, the tubes should be cleaned out frequently—where possible, every day.

The frequency of the cleaning required for the inside of boilers depends entirely upon the nature of the water used; and no general rule can be given, although it may be said that with good water probably three or four times a year would be sufficient. Where there are no calcareous deposits it will only be necessary to draw off any mud or sediment which may be deposited.

It may be said here that the purification of the water before feeding to the boiler seems to be a much better and more rational method than to employ boiler compounds or other methods for preventing deposits. It is easier to make the water pure than to get rid of its defects afterward.

With ordinary stationary boilers, the dampers should not be kept too wide open, the most common fault among firemen being a desire to get a strong draft which will permit them to leave the fire more to itself, and to charge more coal at a time, wrongly supposing that in this way their work is made easier. In charging coal it should be thrown on the grate alternately to right and left, thus securing an equal spreading of the coal over the surfaces of the grate. With small charges we approach almost to continuous feed and the fire will burn much more rapidly. In large boilers the fire-box should be charged at intervals of from 8 to 12 minutes, care being taken that the fire-doors are not left open too long. Between the times of charging, when the coals are of a coking quality, the fireman should look at his fire-box, break up lumps which are brought together, and see that his fire is as even as possible, by filling up vacant spots or places where the fire is low and air can pass through too easily.

Dry coals do not coke or run together. The lumps preserve the forms and intervals, and as the air passes through it more easily, we can use a greater thickness of fire. With these coals we need a directly opposite treatment to the oily coals, and the fire should not be stirred up too often. If it is, too much is lost in the ashes.

The thickness of the fire should correspond with the draft in order to secure complete combustion without any excess of air. It should be determined with care, taking into account the kind of coal and the draft. If we assume a consumption of 75 kgs. of coal per square meter of grate per hour, with charges at intervals of 10 minutes, the quantity of coal would then be about 12.5 kg. to the square meter of grate at each charge.

These are, we believe, the conditions which we ought to try to realize with any system of fire-box. By following these ideas, we can obtain a considerable economy ; especially when re-heaters are used, we increase the power of the boilers, and by employing a sufficient quantity of air and the proper mixture of combustible gases, we will attain an almost complete freedom from smoke.

We may add that it is indispensable that the coal should be stored in a covered shed, for if it is too much exposed the vapor of water absorbed will prevent or decrease in part the combustion of the gases. Certain coals, chiefly those known as gas coals, when exposed to the air undergo a rapid alteration, the combustible gases being disengaged and their heating power is then considerably decreased. Such coal should be used as soon as possible after it is mined. This disengagement of the gases sometimes amounts to a sort of slow combustion.

SPONTANEOUS COMBUSTION.

A theory recently presented by Professor Vivian Lewis, in London, differs from that heretofore adopted in England, but it agrees with that of M. Fayol, Engineer of the Commentry Coal Mines, which was submitted to the Mining Congress at Paris in 1878. He claims that coal possesses in a very high degree the property of condensing gases on its surface, in proportions which vary according to the nature of the coal, its state of division and its density.

Freshly mined coal has not a constant absorptive power, but it can retain at least 1.25 times its own volume of oxygen, and sometimes three times. This action, which is very rapid at first, becomes gradually reduced, and varies with the temperature. It is purely mechanical in its nature, is accompanied by the production of some heat, and depends upon the extent of the surface exposed. The oxygen when condensed in the pores of the coal will quickly combine with the carbon and hydrogen of the coal, which it converts into carbonic acid and vapor of water. The heating of the mass contributes to the quickness of this process and increases little by little ; especially if this action takes place at a certain depth below the surface of the mass, it is easy to comprehend that fire may break out in the center of a pile or a cargo of coal without notice.

The experiments of Mr. Fayol prove that all coals exposed to the air absorb oxygen, and this absorption is always followed by a more or less sensible change in its composition.

Coal in large lumps does not heat even when it is piled up to a considerable height. Small or broken coal will take fire spontaneously when it is in a large pile. It seems to be a little less inflammable when it has been washed. The ordinary mixture of lumps and small coal which is generally called " run of mine" is about the same as washed coal. In dust or slack coal will take fire a little less easily than the run of the mine.

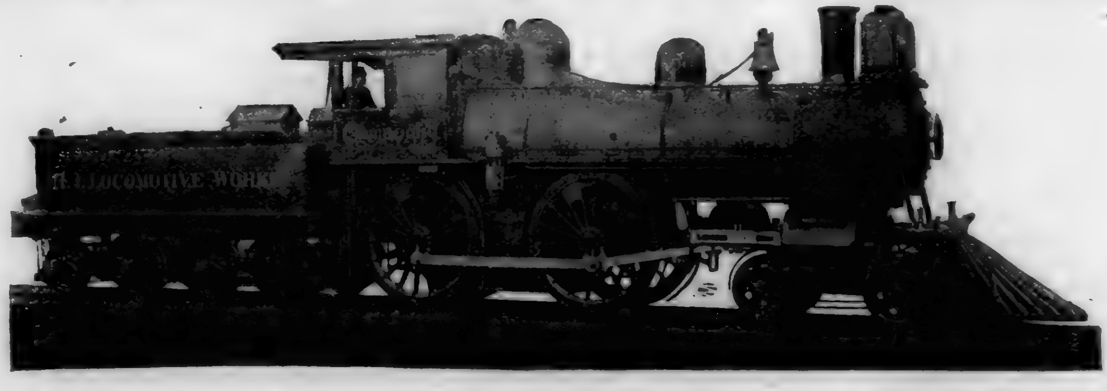
The heating is in almost direct relation with the height and the volume of coal in the pile. If the pile is small the temperature will increase to a certain degree, depending upon circumstances, and will then remain stationary and finally will slowly diminish. There is no example on record of a pile of less than 2 m. in height taking fire, and the temperature will seldom pass 50° C. On the other hand, when the height is over 4 m., spontaneous combustion is almost sure to come after a certain time.

The temperature increases gradually, and in the course of the third month some steam will be given off by the pile ; then colorless, but strongly odorous gas, while some days afterward smoke will appear at a point at about half the height of the pile.

The best method of preserving coal from deterioration consists in exposing it as little as possible to the air and keeping it at a low temperature. The absorption of the oxygen by the coal increases rapidly as the temperature rises, being about ten times as quick at 100° C. as at the ordinary temperature. Dampness prevents the heating rather than favors it, since washed coal when piled up in a damp state changes and heats less than before ; but where the coal is in large lumps dampness may exercise an indirect action by breaking up these lumps and facilitating their reduction to dust. Coals are generally more inflammable as they are lighter, more porous and richer in volatile matters. Coals having much pyrites change but little at the ordinary temperature, but the action is increased in damp air. The order of inflammability of different coals and the temperatures at about which they will take fire may be set down as follows : 1. Lignite, 150° C. ; 2. Gas coals, 200° C. ; 3. Dry coals with short flame or coking coals, 250° C. ; 4. Anthracite, above 300° C.

(TO BE CONTINUED.)

TESTING A COMPOUND LOCOMOTIVE IN EXPRESS SERVICE.



COMPOUND LOCOMOTIVE, RHODE ISLAND LOCOMOTIVE WORKS.

SOME tests have recently been made with a compound locomotive built by the Rhode Island Locomotive Works, and designed for making fast time on trains with few stops. This locomotive—No. 2,600—is of the two-cylinder type, provided with the intercepting valve used by the Rhode Island Works. This valve is so arranged that when the throttle valve is opened at starting, steam from the boiler is admitted directly into the low-pressure cylinder, this admission ceasing when a predetermined pressure in the receiver has been reached by exhausts from the high-pressure cylinder. The engine thus has the advantage of working with high-pressure steam in both cylinders in starting, and the valve is also arranged so that the engineer can change from compound to simple working at will.

The results of these tests have been published by the Rhode Island Works in a very complete form. We give herewith a condensed summary of the results, space preventing the use of the complete tables and other interesting data.

Two tests were made on the New York, Providence & Boston, and two on the Boston & Albany Railroad, the compound No. 2,600 being run on each road with an engine as nearly as possible of the same capacity. The dimensions are given in the table below :

TABLE I. COMPARATIVE DIMENSIONS OF LOCOMOTIVES.

	Compound, No. 2,600.	N. Y., Prov. & B., No. 34.	Bost. & Albany, Nos. 173 & 136.
Fuel used	Soft coal.	Soft coal.	Soft coal.
Cylinder, High-pressure	18 × 24 in.	18 × 24 in.	18 × 22 in.
" Low-pressure	28 × 24 in.		
Drivers, diameter	78 in.	72 in.	70 in.
Boiler, diameter of barrel	52 in.	52 in.	52 in.
" outside diameter of tubes	2 in.	2 in.	2 in.
" number of tubes	214	200	221
" length of tubes	10 ft. 10 in.	11 ft. 10¾ in.	11 ft. 0 in.
Grate, style of	C't i'n r'k'g.	C't i'n, r'k'g.	C't i'n r'k'g.
" size of	78⅛ × 34⅜ in.	72⅛ × 34⅜ in.	71⅛ × 35¼ in.
" area	18.65 sq. ft.	17.72 sq. ft.	17.41 sq. ft.
Heating surface, fire-box	*157.57 sq. ft.	120.95 sq. ft.	116.78 sq. ft.
" " tubes	1,086.26 sq. ft.	1,115.68 sq. ft.	1,119.84 sq. ft.
" " total	1,243.83 sq. ft.	1,236.63 sq. ft.	1,236.62 sq. ft.
Ratio of grate area to heating surface	1:66.69	1:69.78	1:71.02
Weight in working order	103,230 lbs.	91,250 lbs.	91,000 lbs.
" on drivers	66,520 lbs.	60,200 lbs.	61,500 lbs.
" on truck	36,710 lbs.	31,050 lbs.	29,500 lbs.

* Including 19.63 sq. ft. fire-brick tubes.

On the New York, Providence & Boston the conditions were very nearly those for which No. 2,600 was specially designed. The road is 64 miles long, with a rolling profile, there being grades each way from 0.5 to 1 per cent., while the line is practically straight. On this road the trains hauled were through passenger, in the first test consisting of seven and in the second of six cars ; only one regular stop was required on each trip.

The general results of these tests are given in Tables II and III herewith. On the second one the water used was measured; this was not done on the others, chiefly on account of the delay and difficulty caused when taking water on the road. The coal used on this road was ordinary bituminous, about half lumps.

On the Boston & Albany the service was very different, being over a road with many steep grades and bad curves, some of the latter occurring on the worst grades. The speed on down grades is restricted by rule to 42 miles an hour, limiting the amount of time which can be made up. On this road many extra stops and slowings were required in passing freight trains, and because repairs to the track were in progress at different points. The compound was run here with two different locomotives, but both were of the same dimensions throughout, and, as nearly as possible, in the same condition. The coal used on this road was the best quality of Pocahontas, W. Va., well mixed with lumps.

In all the trials the competing engines were run on the same trains, the same number of days, with the conditions as nearly alike as possible, enough days being taken to

TABLE II. SUMMARY OF NEW YORK, PROVIDENCE & BOSTON TEST NO. 1.
Three Round Trips between Providence and New London.

	Compound, No. 2,600.	N. Y., Prov. & B., No. 34.
Total car mileage	2,752	2,752
" coal consumption	9.17 tons.	12.27 tons.
Average amount of coal used per car mile	6.66 lbs.	8.91 lbs.
Percentage of coal saved	25.2 per cent.	....
Average running time, Prov. to N. London	1 hr. 39.6 min.	1 hr. 38.6 min.
" " " N. London to Prov.	1 hr. 44.0 min.	1 hr. 39.0 min.
Average miles per hour, Prov. to N. London	38.63	39.25
" " " " N. London to Prov.	37.21	38.88

Schedule running time from Providence to New London, 64 miles : 1 hr. 40 min.
" " " " New London to Providence, 64 miles : 1 hr. 41 min.

TABLE III. SUMMARY OF NEW YORK, PROVIDENCE & BOSTON TEST NO. 2.
Six Round Trips between Providence and New London.

	Compound, No. 2,600.	N. Y., P. & B., No. 34.
Total car mileage	4,608	4,608
Total coal consumption	13.59 tons.	15.90 tons.
Average amount of coal used per car mile	5.9 lbs.	6.9 lbs.
Percentage of coal saved	14.52 per cent.	....
Averoge running time, Prov. to N. London	1 hr. 30.7 min.	1 hr. 31.0 min.
" " " N. London to Prov.	1 hr. 27.0 min.	1 hr. 27.3 min.
Average miles per hour, Prov. to N. London	43.04	42.84
" " " " N. London to Prov.	44 84	44.72
Water evaporated in boiler	23,812 galls.	25,140 galls.
" used in cylinders	23,706 "	25,087 "
Percentage of water saved, used in cylinders	5.50 per cent.	....
Lbs. water evaporated per lb. of coal	7.30 lbs. from 53.25°.	6.59 lbs. from 43.2°.

Schedule running time, Prov. to N. London, 64 miles : 1 hr. 35 min.; 1 stop.
" " " N. London to Prov., 64 miles : 1 hr. 35 min.; 1 stop.

TABLE IV. SUMMARY OF TESTS ON BOSTON & ALBANY RAILROAD.

Test No. 1. Nine Round Trips between Boston and Springfield, Trains 19 and 18.

Test No. 2. Seven Round Trips between Boston and Springfield, Trains 83 and 50.

	TEST NO. 1.		TEST NO. 2.	
	Compound, No. 2,600.	Bost. & Alb. No. 136.	Compound, No. 2,600.	Bost. & Alb. No. 173.
Total car mileage.......	8,613.5	8,372.5	8.565	8,718
Total coal consumption.	29.0 tons.	39.5 tons.	23.5 tons.	30.5 tons.
Av. am. of c'l per car m.	6.73 lbs.	9.43 lbs.	5 48 lbs.	6.99 lbs.
Percentage of coal saved	28.63%	....	21.60%	....
Av. run. time, B. to S..	2 h. 37.7 m.	2 h. 36 5 m,	2 h. 37.4 m.	2 h. 37.3 m.
" " " S. to B..	2 h. 39.5 m.	2 h. 43.5 m.	2 h. 39.0 m.	2 h. 38.0 m.
Av. m. per hour, B. to S.	37.51	37.75	37.53	37.59
" " " " S. to B.	36.32	36.20	37.18	37.39

TEST NO. 1. Schedule Running Time: Boston to Worcester, 44 miles, 68 min.; Worcester to Charlton, 13.5 miles, 24 min.; Charlton to Springfield, 41 miles, 65 min.; total, including stops, 98.5 miles, 2 hrs. 49 min. *Return trip:* Springfield to Charlton, 74 min.; Charlton to Worcester, 23 min.; Worcester to Boston, 70 min.; total, 2 hrs. 49 min.

TEST NO. 2. Schedule running time: Boston to Worcester, 70 min.; Worcester to Charlton, 24 min.; Charlton to Springfield, 64 min.; total, 2 hrs. 41 min. *Return trip:* Springfield to Charlton, 69 min.; Charlton to Worcester, 22 min.; Worcester to Boston, 68 min.; total, including stops, 2 hrs. 49 min.

secure a fair average. The same engineer handled each engine. The engineers in each test had no previous experience with the compound, but were regular runners on the simple engine. In every way the test was fairly conducted. The results can be seen in the tables given.

In view of the results obtained, the builders claim for this type of engine a saving of 15 to 25 per cent. in fuel. They also claim that the compound engine runs easily, with light oil consumption; that there is a remarkable freedom from cinders and black smoke, owing to the smoother and quieter exhaust. The ability to run as a simple engine, as noted above, enables it to be run with either cylinder singly, in case of a break-down, with no more trouble than an ordinary engine.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(Continued from page 561, Vol. LXV.)

IN the United States very few experiments seem to have been made with flapping wings, and no records of them are attainable. Investigation is, therefore, limited to such proposals as have been patented, and it is found that, aside from balloons, less than 30 flying machine patents have been taken out, of which four are for flapping wings.

The first of these, in order of date, seems to have been the proposal of Mr. *W. F. Quinby*, who patented, in 1869, an apparatus to be operated by man power, consisting of a pair of side wings and a tail, all to be flapped by a series of cords attached to the operator, who is encased in a cuirass which maintains the wings at about the height of his waist. The surfaces shown in the drawings are quite insufficient to sustain the weight, and in 1872 Mr. *Quinby* took out another patent for a modification of his apparatus, in which he added dorsal surfaces, so that the wings and the tail were continuous and resembled the supporting surfaces of a bat. The arrangement for imparting motion was ingenious but futile, because of the inefficiency of muscular power, which has already been stated.

In 1876 Mr. *F. X. Lamboley* patented a framework shaped like the wings of a bird, and covered with a wire netting to which birds' feathers were fastened so as to give a valvular action. Human power was relied upon to impart motion through a trapeze-bar and platform, and of course it would prove inadequate.

In 1877 Mr. *M. H. Murrell* patented an apparatus consisting of a pair of pivoted side wings and a tail, to be also operated by man power. The wings were furnished with slats similar to those of a Venetian blind to close on the down stroke, and open when going up. An investigation of what others had attempted would probably have saved the inventor some misspent time and ingenuity.

So little has been effected with flapping wings that a number of American inventors seem to have turned their attention to various arrangements of revolving vanes. Of these *A. P. Keith* patented, in 1870, an aerial car with paddle-wheels revolving in a transverse plane, for the purpose of lifting and propelling. *Thomas Green* patented, in 1873, an apparatus with two wheels, each with four revolving blades passing through the air flatwise on the down stroke and edgewise on the up, and *M. H. Baldwin* patented, in 1890, an aerial vessel in which weight is to be supported by a set of wheels containing feathering vanes; the wheels revolving in opposite directions on longitudinal shafts. All of these are worthless, as is also the patent of *I. M. Wheeler* of 1887, which covers the arrangement of a number of oscillating frames superposed to each other on a mast, and carrying slats similar to those of a Venetian blind; these various devices only being mentioned to illustrate how ingenuity has been wasted upon mechanical details, while scarcely any attention seems to have been given to the devising of the lightest possible motive power. Each fresh inventor of winged machines is apt to imagine that his predecessors did not succeed because they did not hit upon the right method of imitating the complicated and swift motions of the birds. Thus Mr. *H. Sutton*, of Australia, communicated to the British Aeronautical Society, in 1888, that experiment and observation had convinced him that the tips of the bird's wings describe, when viewed from the side, the outline of an inverted cone with rounded base, instead of the figure of 8 motion described by Dr. Pettigrew and Professor Marcy. He had accordingly made a model, driven by clockwork, to test the truth of his theory. This model was not capable of free flight (steel springs and clockwork being much heavier than rubber, in proportion to their stored energy), but when suspended at the end of a counterweighted lever, resting upon an upright support with a ball-and-socket joint, it flew in a circumference of about 12 ft. by the flapping action of the wings. By slightly modifying the stroke of either wing it was made to fly from right to left or from left to right. By altering the guide-rods, which governed the direction of the stroke, it could be made to fly upward at any desired angle, but

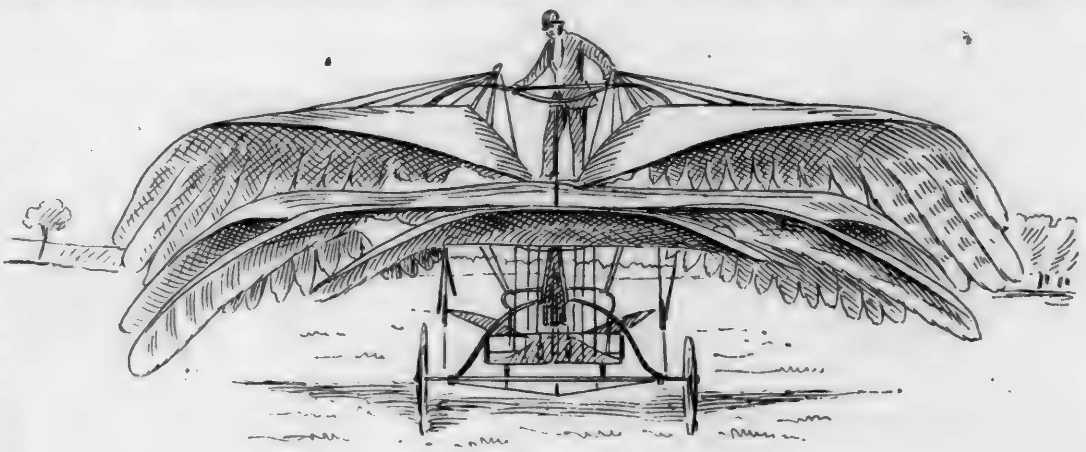


FIG. 22.—FROST—1890.

the important, the vital question of an efficient motor was left untouched by the inventor.

Still, earnest attempts are occasionally made in the direction of light motors. At the meeting of the British Aeronautical Society, in 1890, a photograph was shown of a steam-bird machine, designed and built by Mr. *E. P. Frost*, which is represented in fig. 22. The wings, which are 30 ft. from tip to tip, are in exact imitation of those of the crow, and the various positions which they assume during a stroke are shown in the picture. The weight of the machine, including engine and boiler, is about 650 lbs. It was expected to carry in addition the weight of a man in the air, but it was said that the maker of the engine failed in his contract to secure the necessary power, and the apparatus did not fly.

At the same meeting Mr. *H. Middleton*, who has been advocating for several years winged apparatus as superior, in his judgment, to aeroplanes, exhibited two bird machines, one weighing 20 lbs., with a wing-spread of nearly 12 ft., and the other of between 10 and 12 lbs. weight with a wing-spread of some 9 ft. He also showed an aeroplane weighing somewhat over 20 lbs., with sustaining planes of 14 ft. across and a screw of 4 ft. diameter, in order to compare its performance with those of the bird machines. Only the smaller of these latter was shown in action, but its balance was not properly adjusted, and although it raised itself from the sustaining horizontal rope during the first few strokes, it soon rested again upon the rope, and on the pressure being raised during a subsequent run, the right wing broke and terminated the experiment.

The aeroplane, being similarly suspended, moved along the rope at a moderately good pace, but without raising itself on the air, and that experiment was brought to an untimely end by the rupture of a joint on the propeller shaft.

Probably the most original conception ever presented for a flying machine is that of M. *G. Trouvé*, who has just revived (1891) the proposal for his mechanical bird, which was first presented to the French Academy of Sciences in 1870. This is shown in fig. 23, and consists of two wings, *A* and *B*, connected together by a "Bourdon" bent tube, such as is used in steam gauges. The peculiarity of this tube, as is well known, is that as pressure increases within it the outer ends move apart, and as pressure diminishes they return toward each other. M. *Trouvé* increases the efficiency of this action by placing a second tube within the first, and in the experimental model he produces a series of alternate compressions and expansions by exploding 12 cartridges contained in the revolver barrel *D*, which communicates with the tube. This produces a series of energetic wing strokes which propel and sustain the bird in the air in connection with a silk sustaining plane indicated at *C*.

The manner of starting the bird is equally ingenious and peculiar, and is shown in fig. 24. The bird is suspended from a frame by a thread, which, being attached to the hammer, keeps the latter off the cap. A second thread holds the bird back from the perpendicular, while a common candle *A* and a blow-pipe flame *B* complete the preparations. Upon the thread being burned at *A* the bird swings forward from position 1 to position 2, where the suspending thread is burned by the blow-pipe *B*, the hammer falls on the cap, an explosion ensues, the wings strike downward violently, and the bird flies on an upward course, as shown in position 3. Then the gases escape from the Bourdon tube, this recovers its shape, raises the wings and actuates two pawls which rotate the revolver barrel and work the hammer, so that a fresh explosion occurs and the bird continues to fly. When the 12 cartridges are exhausted the bird glides gently to the ground, being sustained by its wings and aeroplane as by a parachute. It has thus flown 75 to 80 yards.

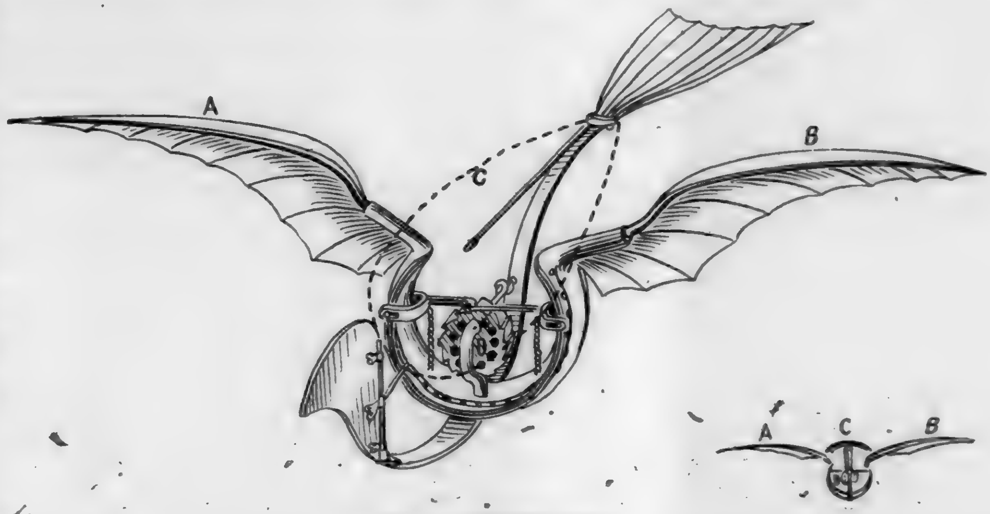


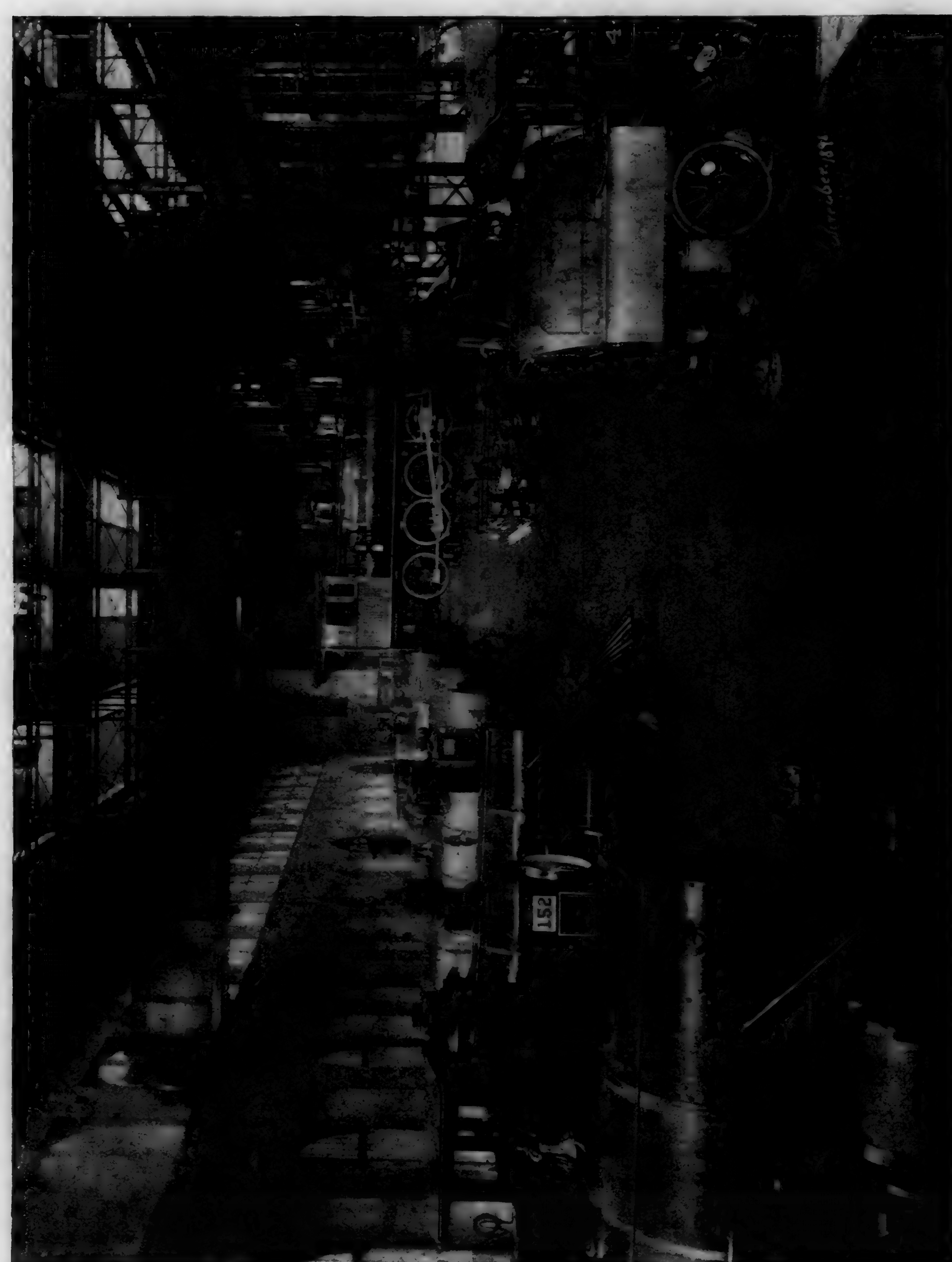
FIG. 23.—TROUVE—1870.

This motor is evidently very simple and very light, and for a practical flying machine M. *Trouvé* proposes to substitute for the cartridges a supply of compressed hydrogen gas, which, when mixed with about three parts of air, becomes an explosive mixture to be fired by the electric spark. Thus the motor would derive the greater portion of its power direct from the atmosphere as wanted, there would be no danger of premature explosion as with fulminates, and, hydrogen being only $\frac{1}{14}$ the weight of air, the weight and the equilibrium of the apparatus would vary but little when supplies became exhausted. Moreover, it is probable that no cooling agent would be required, as in ordinary gas engines, because the tube exposes so great a surface that it is to be expected that the heat would pass into the air while under motion, and that, as there is no piston to be lubricated, a moderate heating would not prove objectionable.

FIG. 24.—STARTING TROUVÉ'S BIRD.

M. *Trouvé* started out with the assumption that a motor for aerial navigation should not weigh over 8 lbs. to the horse power. He presented to the French Academy of Sciences, in 1886, an electric motor, weighing but 7.7 lbs. per horse power, working an aerial screw, which will be more fully noticed when this subject is treated, and on August 24 last (1891) he deposited with the same body a sealed letter containing the drawings and description of an aeroplane and screws, which, he confidently believes, provide a final solution for the problem of aerial navigation, and which will also be noticed under the head of Aeroplanes.

Meanwhile other inventors are also working in the same field, and the English papers have contained sundry paragraphs, within the last few months, concerning a flying



INTERIOR OF NEW ERECTING SHOP, BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

machine some 45 ft. across, in the form of a bat, which is being built in Coventry for Major Moore, of India. It is to be driven by an electric motor, but the descriptions do not make it clear whether this is to be by beating wings or with fixed wings, as in an aeroplane. The cost incurred is stated at over $5000, and the trial is to take place at the Crystal Palace. Should this take place in time, it will be noticed, as well as the great apparatus now being completed by Mr. Maxim, when we come to discuss aeroplanes.

AN ERECTING SHOP INTERIOR.

THE accompanying large engraving is from a photograph showing the interior of the new erecting shop of the Baldwin Locomotive Works in Philadelphia, and gives a very good idea of the appearance of this shop in busy times.

One special feature about the shop is the large traveling crane which is shown prominently in the picture There are two of these cranes, each of 100 tons capacity, running side by side in the shop, and either one of them is able to pick up and transfer a locomotive of the largest class from one track to another. One of them, it will be seen, is in the act of moving a large consolidation engine in this way.

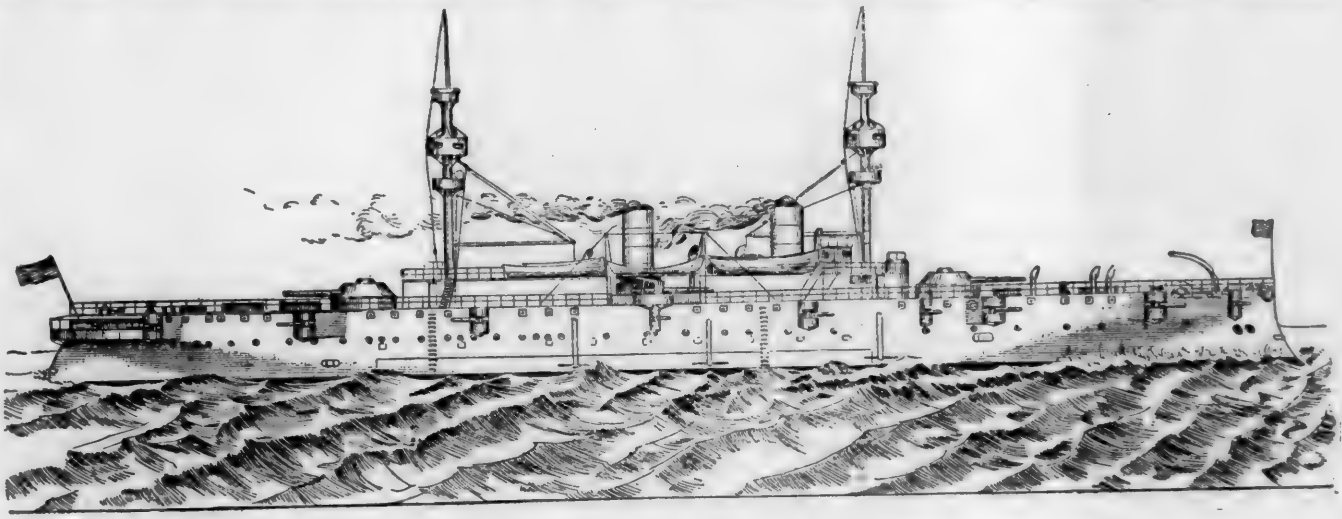
Each crane runs the length of the shop on tracks resting upon the wall on either side, and on girders supported by columns in the center. It is provided with two lifting trolleys of 50 tons capacity, the power being conveyed to these trolleys by a square shaft running the entire length of the bridge inside the girders. The cranes were built by William Sellers & Company, of Philadelphia, and at their suggestion electricity was adopted as the motive power. On each crane there are two 40-H.P. Westinghouse constant-potential shunt-wound motors, mounted on the top of the bridge and geared independently to the driving machinery. These motors run in the same direction at all times, the reversing being done by friction clutches. Through these clutches the power is distributed to the various points of the crane for moving the bridge, moving the lifting trolleys, and hoisting the load.

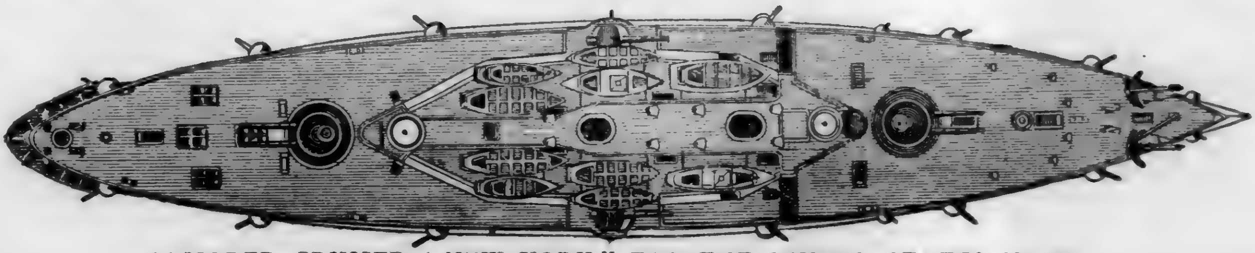
In addition to the trolleys for heavy work a quick hoist is used for lifting small loads under 100 lbs. This is operated by a 5-H.P. Wenstrom motor, series-wound and reversible, which is controlled from the main platform of the crane. This motor and drum move backward and forward with the trolley, the current being taken to the motor through a cable which hangs at the side of the bridge, from small wheels arranged for the purpose.

Both cranes move the entire length of the shop. The carriages or trucks carrying the bridges run on steel rails weighing 135 lbs. per yard, which were rolled especially for this plant. They work very smoothly and easily and have proved a great saving of time and work, as a locomotive or a boiler can be moved the whole length of the shop in five minutes. For all lighter work one of the 40-H.P. motors is run, the other one being started only in case of necessity.

The current for the motors is furnished by two Westinghouse constant-potential, compound-wound generators, each of 80,000 Watt capacity, and each driven by a Westinghouse compound engine. The current is conveyed to the motors on the crane by an overhead double-trolley line, each trolley wire being ½ in. in diameter and carefully insulated. The current is taken from the wires by Wheeler trolleys, each having four wheels, and each crane has two trolleys.

The electrical work was done by the Equitable Engineering & Construction Company of Philadelphia, and the whole plant has served its purpose very well thus far. In addition to the two traveling cranes there are in use in the shop four jib cranes run by electrical motors. These cranes have a capacity of from 5 to 10 tons, and each one is run by a 5-H.P. Wenstrom motor.



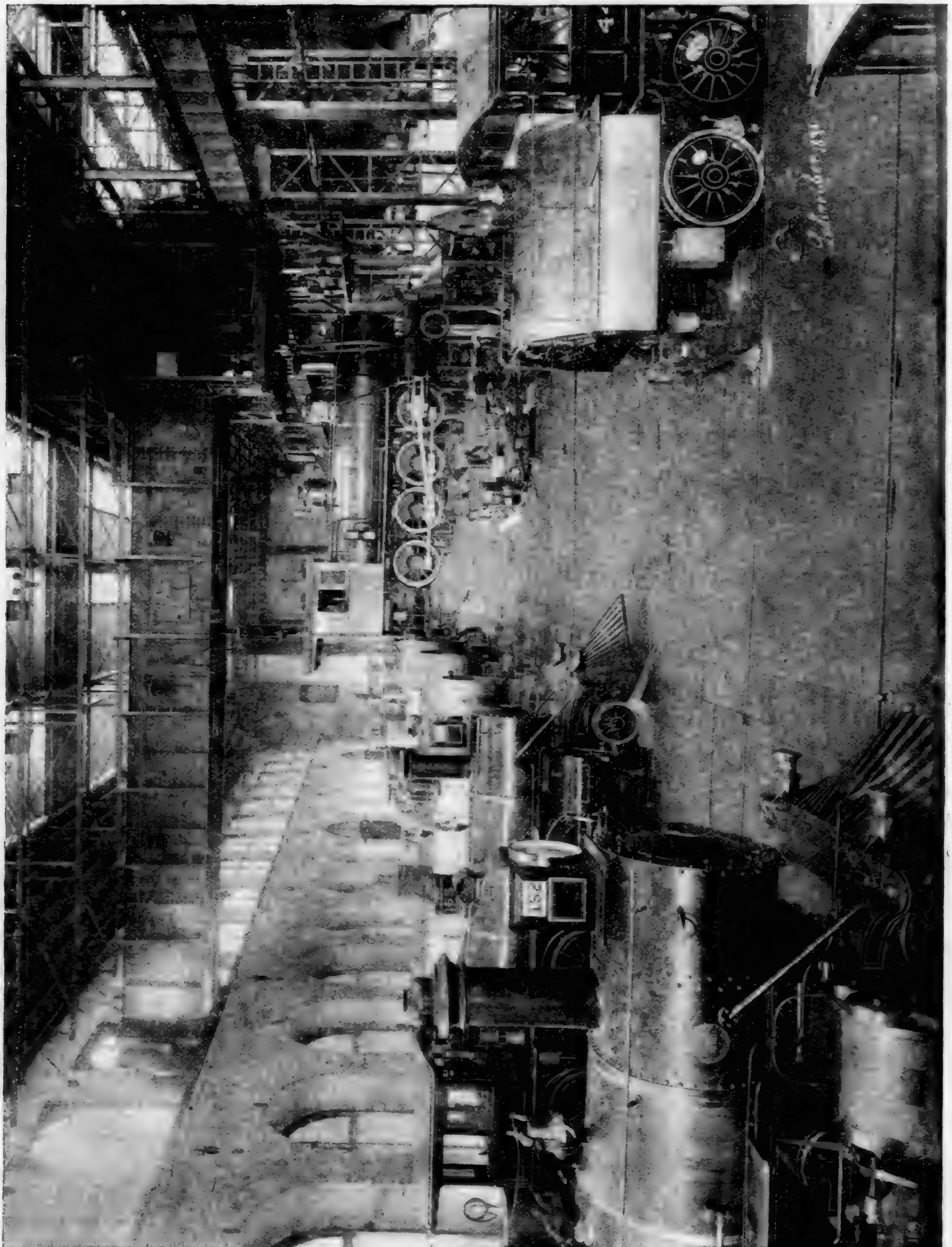


ARMORED CRUISER "NEW YORK," FOR THE UNITED STATES NAVY.

THE UNITED STATES NAVY.

THE armored cruiser *New York* was successfully launched from the Cramp yards in Philadelphia, December 2, the launch being witnessed by a large and distinguished company. The *New York* is the second ship of this type undertaken for the Navy—the *Maine* being the first—and is the largest ship yet launched for the Navy.

The new ship is 380 ft. 6 in. in length on the water-line, 64 ft. beam, and will have, when completed, a displacement of 8,150 tons, and a mean draft of 23 ft. 3 in. She



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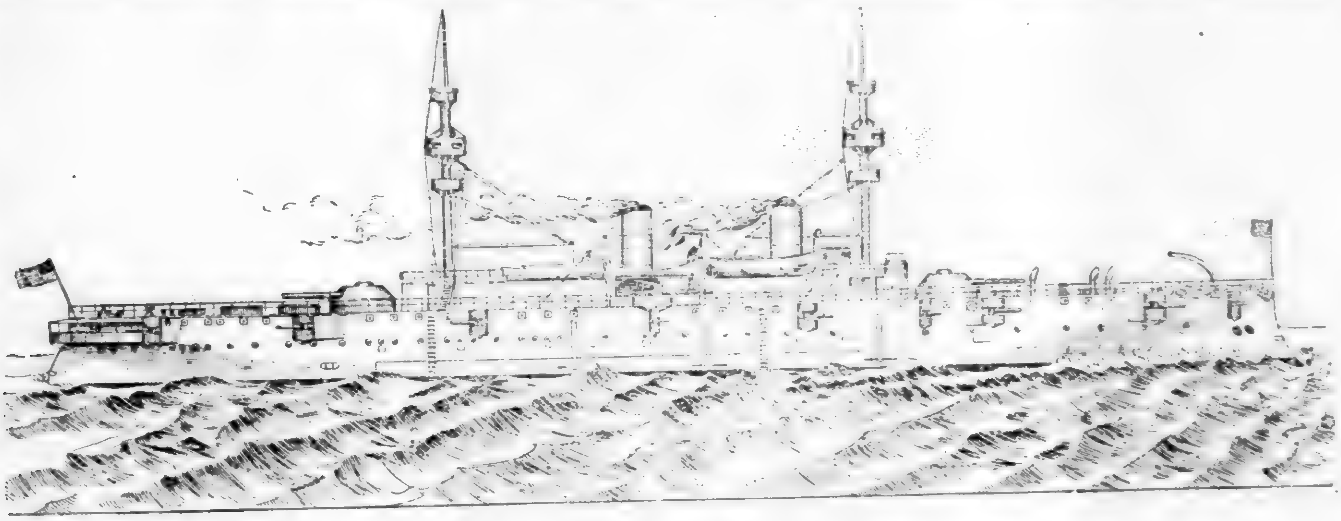

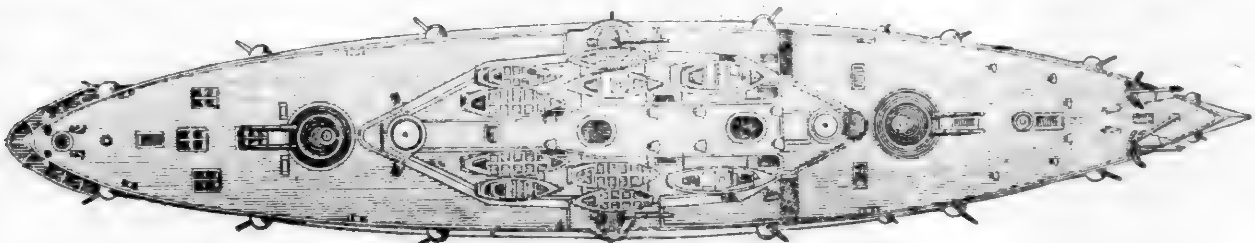

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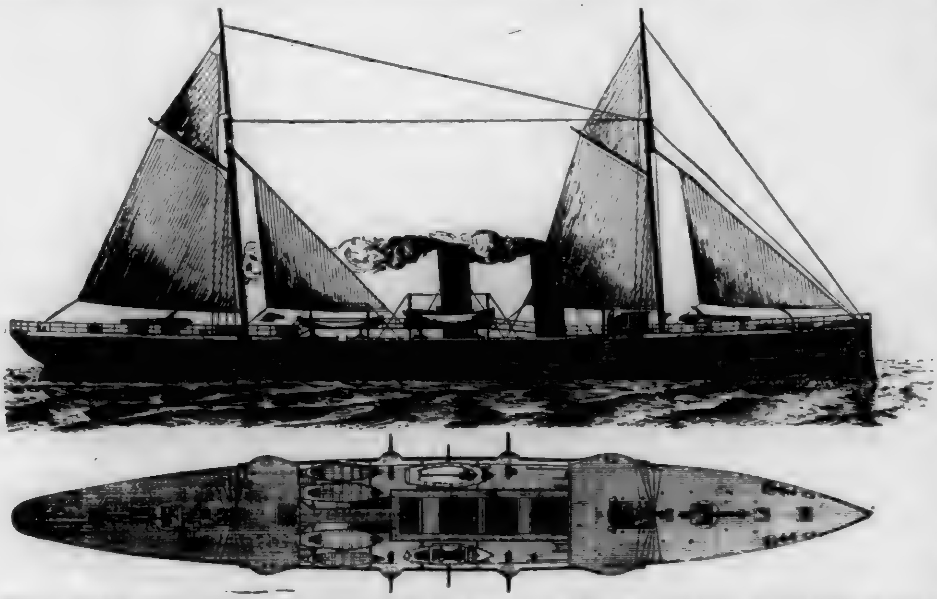
The new ship is 380 ft. 6 in. in length on the water-line, 64 ft. beam, and will have, when completed, a displacement of 8,150 tons, and a mean draft of 23 ft. 3 in. She

will be exceeded in displacement by the three battle-ships now under construction, and in length by cruisers Nos. 12 and 13, but is a very powerful ship in size and armament. She is expected to reach a speed of 20 knots an hour.

The main battery consists of six 8-in. breech-loading rifles and twelve 4-in. rapid-fire guns; the secondary battery of 12 smaller rapid-fire guns, four 37-mm. (1.46-in.) revolving cannon, and four machine guns.

The hull is protected by a vertical armor-belt over the machinery space, and by a steel protective deck from 2½ to 6 in. thick, extending from stem to stern. Within the armor-belt and above the protective deck a coffer-dam 3½ ft. wide extends the whole length of the ship, filled with cellulose.



THE NEW CRUISER "MONTGOMERY," FOR THE UNITED STATES NAVY.

The 8-in. guns will be carried in barbettes with 10-in. armor, which will protect the carriages, platforms and loading positions; over the guns will be shields 7 in. thick. The ammunition hoists and spaces below the heavy gun-mounts will have cone-shaped armor 5 in. thick. The 4-in. guns will have segmental shields of 4-in. plate, and the armor of the conning-tower will be 7½ in. thick.

This ship has twin screws and four engines, two on each shaft, so arranged that the forward engines can be uncoupled and only the after engines used when cruising at slow speed. The engines are of the vertical, inverted cylinder, direct-acting, triple-expansion type, the cylinders being 32 in., 46 in. and 70 in. in diameter, with 42 in. stroke. The valves are all piston valves, driven by link motions. The bedplates are of cast steel, and the engine framing consists of cast steel inverted Y-frames, two to each cylinder. There is one condenser and one auxiliary condenser to each engine, and the circulating and air pumps are worked by independent engines.

Steam is furnished by six double-ended boilers, of the horizontal return fire-tube type, each 15 ft. 3 in. in diameter and 21 ft. 3 in. long, and each having eight corrugated furnace flues 3 ft. 3 in. inside diameter. There are also two single-ended auxiliary boilers, each 10 ft. in diameter and 8 ft. 6 in. long, and each having two corrugated furnaces 2 ft. 9 in. inside diameters. All the boilers are built for 160 lbs. working pressure.

For forced draft there are six blowers—three to each fire-room—for the main boilers, and one blower to each auxiliary boiler.

It will be seen that this ship differs from all the other cruisers in having four engines, of which two will be sufficient for ordinary cruising, the others to be used only when high speed is required. These engines are expected to develop 16,000 H.P., and to propel the ship at a speed of 20 knots an hour.

The coal carried at normal displacement will be 500 tons; but the ship will be able to carry 1,500 tons altogether; this will give her a cruising endurance of 13,000 knots, at a speed of 10 knots an hour.

THE LAUNCH OF THE "MONTGOMERY."

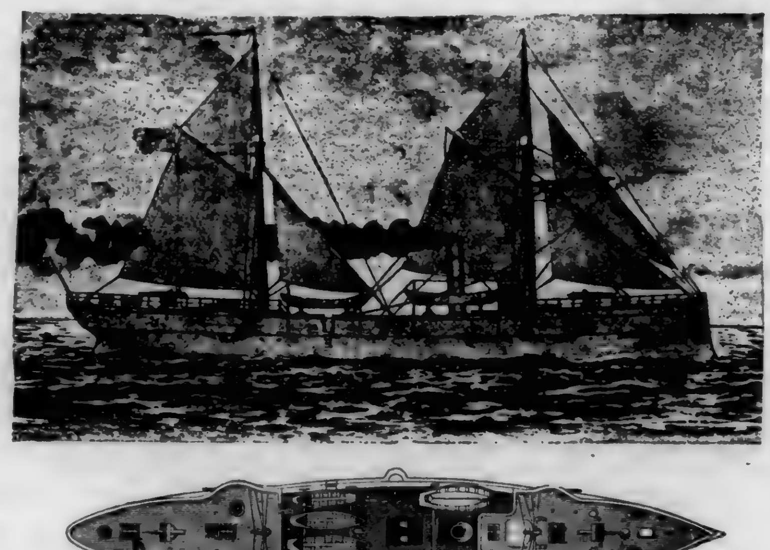
Cruiser No. 9, which was launched from the yard of the Columbian Iron Works in Baltimore, Md., December 7, has been named *Montgomery;* she is a sister ship to the *Detroit*, which was described in the December number of the JOURNAL. For convenience of reference the brief description is here repeated, and a sketch of the ship given, which is essentially the same as that of the *Detroit*, differing only in the point of view.

The *Montgomery* is an unarmored steel cruiser 257 ft. in length and 37 ft. beam, and will have a mean draft of 14 ft. 6 in. The machinery is covered by a protective deck varying from ⅜ in. to ⅞ in. in thickness, and is further protected by a coffer-dam filled with cellulose and by the arrangement of the coal bunkers. Her displacement with a normal load is 2,000 tons.

The ship has twin screws, each driven by a triple-expansion engine of the vertical inverted type, having cylinders 26½ in., 39 in. and 63 in. in diameter and 26 in. stroke. The engines are expected to develop 5,400 H.P., with 160 lbs. boiler pressure and running at 185 revolutions. There are three double-ended boilers 11 ft. 8 in. in diameter and 18 ft. 8 in. long, and two single-ended boilers 11 ft. 8 in. in diameter and 9 ft. 2 in. long. The forced draft is on the closed ash-pit system.

The coal bunkers will hold 200 tons, and extra bunkers are provided so that 435 tons can be carried. With the latter supply the cruising range is 8,950 knots at a 10-knot speed. The contract speed with full power is 17 knots an hour.

The armament carried will consist of two 6-in. and eight 4-in. rapid-fire guns. The secondary battery will include four 6-pdr. and four 3-pdr. rapid-fire guns and two 37 mm. (1.46 in.) revolving cannon. There will also be six torpedo tubes.



GUNBOAT "MACHIAS," UNITED STATES NAVY.

LAUNCH OF THE "MACHIAS."

The third launch of the month was of gunboat No. 5, which was successfully launched from the yard of the Bath

Iron Works, at Bath, Me., on December 8, 1891, in the presence of a large assembly.

This ship, which has been named the *Machias*, is one of two vessels the construction of which was authorized by Congress in 1889. The contract was let to the Bath Iron Works in April, 1890, that company having bid for both ships; the contract price was $637,000. No. 6, which will be a duplicate of No. 5, will be launched early in the year, and both ships will be ready for service early in the summer of 1892.

The *Machias* is a steel gunboat of the following dimensions: Length on load water-line, 190 ft.; beam, 32 ft.; mean draft, 12 ft.; displacement, 1,050 tons. She has no armor; but the engines and magazines are protected by coffer-dams filled with woodite, and by the arrangement of the coal-bunkers.

There are two screws, each driven by a vertical triple-expansion engine, with cylinders 15 in., 25 in. and 34 in. in diameter and 24 in. stroke. There are four boilers, each 10 ft. in diameter and 17 ft. 6 in. long. The contract speed is 14 knots an hour. The coal capacity is 250 tons, which will give a cruising limit of 2,450 knots at 14-knot speed and 4,700 knots at 10-knot speed.

The *Machias* will carry a heavy armament for her size. The main battery will consist of eight 4-in. rapid-fire guns, one mounted on the forecastle; one on the poop deck; three on each side in sponsons on the main deck. These six guns will each have an arc of about 70° of fire. The secondary battery will include four 6-pdr. and two 1-pdr. rapid-fire guns and two Gatling guns.

There will be two masts, with fore-and-aft rig, and about 6,500 sq. ft. of canvas can be spread. The ship will have steam steering gear, electric lights and other modern fittings, and very comfortable quarters for officers and crew.

With her light draft and heavy battery of rapid-fire guns, the *Machias* and her sister ship will be very useful vessels on some of the foreign stations, as in China and South America, and might be also of use as auxiliaries in coast defense.

"WAS IT IRON OR STEEL?"

BY H. DEB. PARSONS, M.E.

THE following is in brief the testimony of the author in a suit brought to recover an alleged overpayment of duties by Messrs. Matthew Farris, *et als*, against Daniel Magone, Collector of the Port of New York, because the Government had classified the imported metal in question as steel, and had collected duties in accordance with that classification. It is of interest as showing the methods adopted to decide the question.

On October 3, 1890, the author was retained by the Government to examine a sample of the importation, and as his report sustained the position already taken, he was called as an expert witness in the case which came to trial before Judge Lacombe and a jury in the United States Circuit Court, April 15, 16, 17 and 20, 1891. Mr. James T. Van Rensselaer, Assistant District-Attorney, conducted the case for the defendant, in whose favor the suit was decided.

Commercial steel may be considered as an alloy of iron, and is made by different processes, all of which may be classified under one of three different heads: Process of decarbonization, process of cementation and the direct process.

These processes were then described in brief.

The elements that compose steel are numerous, consisting chiefly of iron, carbon, manganese, phosphorus, sulphur, silicon, chronium and many others of minor importance. Carbon is generally found between the limits of 0.2 and 2 per cent., and is either in a free or combined state. The other elements occur, in general, between the following maximum limits:

Manganese,	from 0 to 1.0 per cent.
Phosphorus,	from 0 to 0.1 " "
Sulphur,	from 0 to 0.2 " "
Silicon,	from 0 to 0.5 " "

The characteristics peculiar to steel are chiefly its tensile strength, its property of hardening when heated and suddenly cooled, and its capability of being forged. Its structure is granular, and in general the more the steel is worked the finer and more homogeneous its structure. A coarse granular structure is often found in steel made by some direct process from the ores which has been little worked. Steel belongs midway between wrought iron and cast iron, and these three grades of "the irons," as they are sometimes called, have no defined lines of distinction. In general, however, the cast irons will chill, the steels temper, while the wrought irons will not harden at all.

The characteristics of steel were then defined in detail; and in reply to a question, the author then described the physical tests made by him on a sample of the imported metal. These tests were made as follows:

The sample of metal was about 3 in. long by 2 in. wide and 1⅛ in. thick, broken off from a large piece or slab.

Fig. 5.

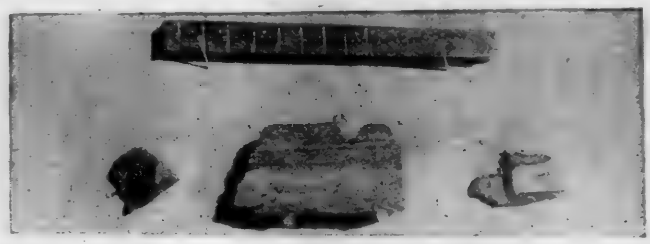


Fig. 2. Fig. 1. Fig. 3.

The top and bottom sides were oxidized, while the fractured edges showed a crystalline structure, and in appearance it resembled either a forge iron, a white cast iron or a steel. The original piece was photographed, as also the result of each different experiment, and these photographs as well as the specimens were exhibited in court. The

Fig. 4.

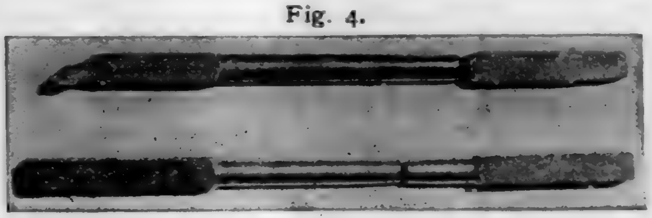


Fig. 6.

original sample was cut in two parts on a planer, the chuck and tool being cleaned with ether to remove all foreign particles, and the chips were saved for analysis. This analysis, as well as the others given below, was made by Mr. J. H. Wainwright, Ph.B., and are given in the table in column *A*. One of the pieces was kept to be exhibited in court, as a sample of the original piece; this is shown in fig. 1. The other piece was forged at a red heat into a bar ⅝ in. square by about 12 in. long. The metal forged very well indeed, and thus proved itself not to be a cast iron. During the forging two chips were cut off, one being plunged into water while red hot; this is shown in fig. 2; the other being annealed in air, and shown in fig. 3. The former was tempered to a high degree of hardness, such as steel alone will take, while the latter remained quite soft and easily filed.

The bar was then broken cold by nicking with a cold chisel and striking with a hammer, the fracture showing a fine granular structure, as is seen in steel. A piece of the best Stubbs tool steel was procured and forged down to a square bar similar to the one of the imported metal, and in like manner was broken cold. The fracture of the Stubbs steel showed a corresponding fine granular structure.

One end of the bar of the imported metal was then heated to a white heat until it began to burn, and was then cooled in air. It did not crumble readily under the hammer, proving again it could not be cast iron. The bar

was then broken into two pieces, one of which was put into a lathe and turned into a test piece, shown in fig. 4. The other was tested for the temper tests, and is shown in fig. 5. This latter piece tempered very well indeed in water, showing the colors beautifully; one end being hard enough to easily scratch glass, while the other was quite soft. To further prove its degrees of hardness, it was tried with a fine triangular file. The file took hold very readily on the soft end, but before the hard end was reached, the file not only refused to mark the bar, but actually lost its edge. These temper tests prove that the metal was not wrought or forged iron, but steel of a high grade.

In tuning the test piece the chips were saved, which gave the analysis in column *B* of the table. It will be noticed that the process of heating and forging did not materially alter the composition of the metal.

A similar test piece was also made from the forged bar of Stubbs steel, fig. 6, the analysis of which is also given in the table in column *C* by way of comparison. These test pieces were then broken on a standardized Riehlé Brothers' testing machine, with the following results:

Tensile Tests.

	Imported.	"Stubbs."
Length between marks	3.000 in.	3.000 in.
Diameter	0.368 in.	0.350 in.
Area in square inches	0.1064 sq. in.	0.09621 sq. in.
Breaking stress, actual	13,770 lbs.	11,200 lbs.
Strength, per sq. in	129,420 lbs.	116,410 lbs.
Extension, actual	0.05 in.	0.19 in.
" percentage	1.7 per cent.	6.3 per cent.

Chemical Analysis.

	A, Imported.	*B*, Imported.	*C*, Stubbs.
Carbon	1.261	1.208	1.492
Silicon	0.049	0.048	0.086
Sulphur	0.011	0.011	0.020
Phosphorus	0.034	0.034	0.022
Manganese	0.469	0.474	0.094
Iron (by diff.)	98.176	98.225	98.286
	100.000	100.000	100.000

It will be seen that the sample of imported metal was over 11 per cent. stronger than the Stubbs steel. The small percentage of elongation was to be expected with such great tensile strength.

In order to test more thoroughly the character of the imported metal, a "side" tool was made on the end of the larger test piece. With this tool there was cut in a lathe a piece of unannealed octagonal tool steel. Although the cut was excessively heavy, far greater than is ever done in practice, and the metal operated on a hard unannealed tool steel, the tool did not lose its cutting edge, but stood up to its work as only the best of hard steel could do. The cut was made dry, and that is the reason the turning was not smoother.

From the above experiments, it was the author's opinion that the sample of imported metal was a high grade of steel; that it was steel because it not only had the chemical composition of steel, but had all its physical characteristics. It forged readily; it tempered well at a low heat, and took all the degrees of hardness peculiar only to steel; it had a very high tensile strength; it had the fine granular structure of steel, and lastly it made a very excellent tool. It was termed a sample of steel, as it had all the distinguishing characteristics peculiar to steel; and, finally, it was undoubtedly steel, as its chemical and physical properties would not be consistent with either cast or wrought iron.

Fig. 1. TRIAL OF OCTOBER 31.

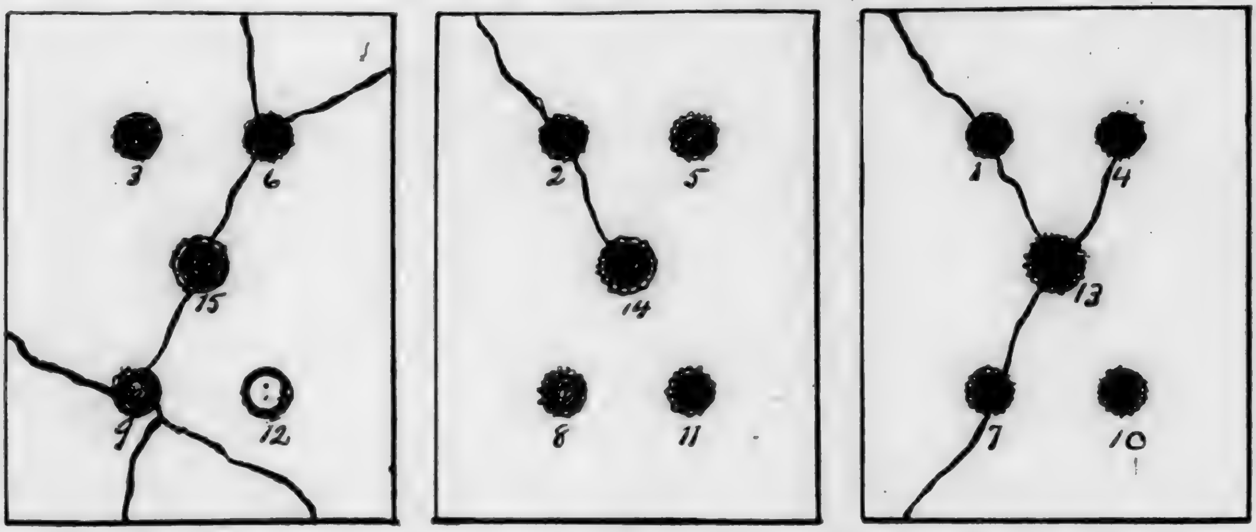


Plate No. 3. Plate No. 2. Plate No. 1.

THE TRIAL OF AMERICAN-MADE ARMOR-PLATE.

By Lieutenant J. M. Califf, Third U. S. Artillery.

At the conclusion of the Annapolis armor tests last September, when the Schneider nickel plate so handsomely carried off the honors, it is not probable that the most enthusiastic believer in the skill and enterprise of American metal-workers supposed for a moment that within about a twelvemonth not one only, but at least two home-made plates would surpass the Creusot product, with one or two others giving it a close race for the mastery.

The trials took place on the new Naval Ordnance Proving Ground at Indian Head, Md., on October 31 and November 14 last, three plates being tested upon each occasion. These trials were to test the quality of American-made plate, to settle the questions of the value of nickel, of face-hardening and of the percentage of carbon to be employed, or, in other words, the hardness of the plates, and incidentally, the comparative resisting power of the hammered and rolled plate.

The competing firms were the Bethlehem Iron Company and Carnegie, Phipps & Company, of Pittsburgh, Pa. The Bethlehem plates were all forged under the hammer; the Pittsburgh plates were rolled. Each firm had its own method of tempering; both submitted plates of high and low carbon and those face-hardened by the Harvey process. In this process, it will be remembered, the face of the plate is exposed to the action of carbonaceous gases at high temperature, the back being protected meanwhile; the result being an exceedingly hard face, while the remainder of the plate retains its original toughness.

The plates tested were: No. 1, Bethlehem high-carbon (.30 of 1 per cent.) nickel steel. No. 2, Pittsburgh low-carbon (.24 of 1 per cent.) nickel steel. No. 3, Bethlehem low-carbon (.27 of 1 per cent.) all steel (Harvey). No. 4, Pittsburgh high-carbon (.40 of 1 per cent.) nickel steel. No. 5, Pittsburgh low-carbon (.25 of 1 per cent.) nickel steel (Harvey). No. 6, Bethlehem high-carbon (.35 of 1 per cent.) nickel steel (Harvey).

The first three of these plates were tested on October 31, the remainder on November 14. The plates were of the uniform dimensions of 6 ft. × 8 ft. × 10½ in., well backed and braced. The guns were the new 40-caliber 6-in. and a 35-caliber 8-in. rifle. With the 6-in. gun the charge was 42 lbs. brown powder; projectile, Holtzer steel, 100 lbs.; striking velocity, 2,075 foot-seconds; striking energy, 2,988 foot-tons, giving a calculated penetration in wrought iron of 13.2 in., or in steel of about 10.56 in. With the 8-in. gun the charge was 74½ lbs. of powder; projectile, Firminy steel, 210 lbs.; striking velocity, 1,850 foot-seconds; striking energy, 4,988 foot-tons, giving a calculated penetration in wrought iron of 14.74 in., or of about 11.80 in. in steel. Upon the last day's trial two Carpenter 250-lb. 8-in. shells were substituted for Firminy, but the charge was reduced sufficiently to make their striking energy about the same.

Comparing the results of these trials with those of last year, it will be noticed that the behavior of Plate No. 2 was almost identical with that of the Schneider nickel plate at Annapolis—both admitting of great penetration with little inclination to crack—although the former did have one unimportant crack. The all-steel French plate of last year broke into four pieces when taken from its backing; the only plate that failed to hold together this year was Plate No. 4, the lower left-hand corner becoming detached. The backing of the two plates placed at the head of the list was practically uninjured, while the two shots on Plate No. 6 produced only the faintest trace of a bulge.

FIG. 2. TRIAL OF NOVEMBER 14.

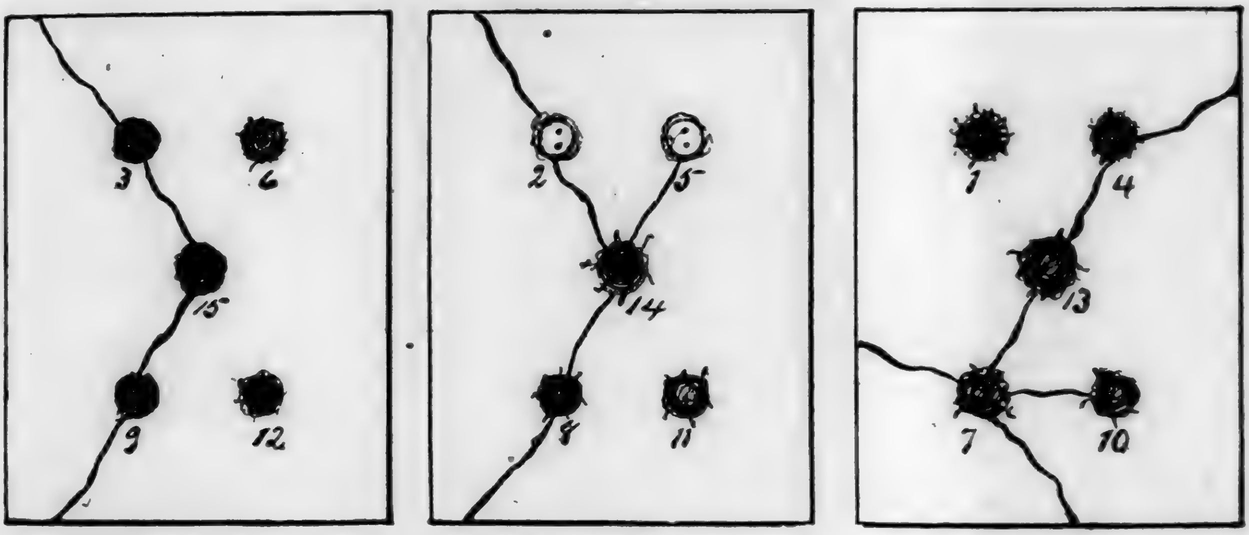


PLATE NO. 6. PLATE NO. 5. PLATE NO. 4.

In the matter of penetration it may be interesting to compare the results obtained in this regard from the Creusot nickel plate and the best Bethlehem plate just tested. Taking the shots in order, the penetrations were: Creusot, 1890—15.65 in., 15.15 in., 13.90 in., 13.90 in., 20.90 in.; Bethlehem, 1891—12 in., 5 in., 12.25 in., 5.50 in., 12.87 in. The weight of projectile and striking energy were identical.

The results may be arranged in tabular form as below:

TABLE I. TRIAL OF OCTOBER 31 (FIG. 1).

No. of Shot.	Character of Plate.	Penetration, inches.	Effect upon Projectile.	Effect upon Plate.
1	Bethlehem high carb. n'k'l, Plate No. 1.	13	Rebounded—uninjured.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
4	" " " " " "	9	Broken into fragments.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
7	" " " " " "	13	Rebounded—uninjured.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
10	" " " " " "	10¾	Broken up.	Symmetrical burr, 1 in. in height, raised about shot-hole—no cracks.
13	" " " " " " (8-in. proj.)	16½	Rebounded.	Cracked as shown in cut. Crack to upper left-hand corner, through and ½ in. wide at top of plate.
2	Pittsburgh low carb. n'k'l, Plate No. 2.	29½	Embedded in plate.	Burr raised as in shot No. 1. Proj. 19 in. into backing.
5	" " " " " "	26¾	" " "	Almost entire length of shell in backing.
8	" " " " " "	20¼	" " "	Half length of shell in backing.
11	" " " " " "	13½	Broken up.	Burr raised as before—no cracks.
14	" " " " " " (8-in. proj.)	22	Embedded in plate.	Base of shell 1 in. below face of plate, appearance of plate as shown.
3	Bethlehem low carb. all steel, Pl. No. 3.	8	Broken—point in plate.	Irregular burr raised, fragments of which broken off.
6	" " " " " "	8	Broken up.	Upward crack from shot-hole to edge of plate 3 in. in depth—burr as before, larger fragments broken off
9	" " " " " "	27½	Embedded in plate.	Base of proj. sunk over 9 in. below surface of plate.
12	" " " " " "	6	Embedded ⅜ length in plate.	Two cracks started from shot-hole No. 9 toward lower right-hand corner and to bottom of plate.
15	" " " " " " (8-in. proj.	43½	Embedded in plate.	Badly cracked, as shown. Plate practically destroyed.

TABLE II. TRIAL OF NOVEMBER 14 (FIG. 2).

No. of Shot.	Character of Plate.	Penetration, inches.	Effect upon Projectile.	Effect upon Plate.
1	Pittsburgh high carb. n'k'l, Plate No. 4.	12⅜	Rebounded—uninjured.	Irregular burr about shot-hole, fragments broken off.
4	" " " " " "	10⅝	Rebounded—broken up.	Burr as before—short radial cracks.
7	" " " " " "	12	" " "	Crack from shot-hole to bottom of plate.
10	" " " " " "	11⅝	" " "	Existing crack widened, new crack started from shot-hole through No. 7 to edge of plate.
13	" " " " " " (8-in. proj.)	9⅝	" badly upset.	Existing cracks greatly widened, additional cracks as shown, metal chipped off around shot-hole.
2	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	14½	Embedded in plate.	Short radial cracks through burr, metal chipped off.
5	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	14¾	" " "	" " " " " " " "
8	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Plate No. 5.	9¾	Rebounded. Set up 2".	" " " " " " " "
11	Pittsburgh low car. n'k'l, face-hardened, Harvey process. Plate No. 5.	20⅛	Embedded in plate.	Base of shell 3" below face of plate, other conditions as before.
14	Pittsburgh low car. n'k'l, face-hardened, Harvey process, Pl. No. 5 (8-in. proj.)	15¾	Rebounded—broken up.	Cracked in both directions, as shown. Short radial cracks about shot-hole.
3	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	12	Rebounded—badly broken up.	But little burr, metal chipped off about shot-hole. No bulge.
6	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	5	Point in plate, remainder in fragments.	Point of projectile apparently welded to plate. No cracks, burr or bulge.
9	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	12¼	Rebounded, intact.	Number of small radial cracks about shot-hole.
12	Bethlehem high car. n'k'l, face-hardened, Harvey process, Plate No. 6.	5½	As in No. 6.	Exactly as in shot No. 6.
15	Bethlehem high car. n'k'l, face-hard., Harvey process, Pl. No. 6 (8-in. proj.).	12⅞	Rebounded, slightly chipped.	Cracks through left-hand shot-holes, as shown.

The report of the official Board places the plates in the following order of merit:

1. Bethlehem high-carbon nickel-steel (Harvey) plate (No. 6); 2. Bethlehem high-carbon nickel-steel plate (No. 1); 3. Pittsburgh high-carbon nickel-steel plate (No. 4); 4. Pittsburgh low-carbon nickel-steel (Harvey) plate (No. 5); 5. Pittsburgh low-carbon nickel-steel plate (No. 2); 6 Bethlehem low-carbon all-steel (Harvey) plate (No. 3).

The result of these trials has been to confirm very emphatically the claims made on behalf of nickel after last year's experiments. The value of face-hardening was also demonstrated; but as at present applied, the Harvey process is an expensive method, and difficult to employ. Improvement in this last respect is hoped for in the direction of being able to apply it to the ingot before it is hammered or rolled.

A glance at the tables will show a great want of uniformity in the penetration of like projectiles in the same plate; noticeably so in Plate No. 3 of the first trial and No. 6 of the last. This is explained upon the ground that in the tempering process the different parts of the plate received a different degree of temper, owing to defective methods employed. In Plate No. 6 it may be said that only one-half of the plate was properly treated.

From an economical point of view, perhaps the most important question settled by these trials is that rolled armor-plate approaches very nearly in resisting qualities the hammered product. The latter process possesses the advantage of not only being cheaper, but as requiring much less time for its fabrication.

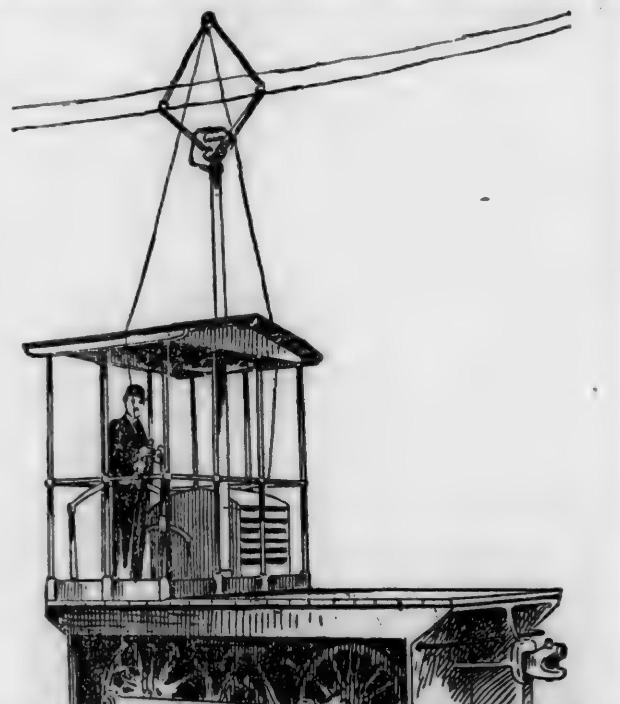
It is understood that the orders for the armor-plate for the vessels now building will be divided between the Bethlehem and Pittsburgh firms—the first coming from Bethlehem for the *Monterey*.

It is surely a matter for congratulation that, in this the first trial of American-made steel plate, it should have proved itself, under a test that has never been exceeded in severity, the superior of any armor ever yet brought to the trial ground.

An Electric Freight Locomotive.

THE accompanying illustrations show the first large electric freight locomotive built in this country, just completed by the Thomson-Houston Electric Company at the factory at Lynn, Mass. Fig. 1 is a general view, and fig. 2 shows the running gear with the platform removed.

This machine is designed to pull and shift freight cars at Whitinsville. The Whitin Machine Company, for which the machine has been made, proposes to carry merchandise back



THOMSON-HOUSTON ELECTRIC LOCOMOTIVE.

and forth from the railroad station to the works, a distance of 1½ miles, by electric power.

The locomotive is equipped with a powerful motor of the "G" type of the Thomson-Houston Electric Company.

The power is communicated from the armature to the rear axle by double reduction gearing, and from the rear axle to the forward one by parallel rods.

The locomotive is built in a square form, with a platform for carrying loads, and with cow-catchers and draw-bars at each end.

The power is to be furnished by a large generator located at the works of the machine company and conveyed over a trolley wire, from which it is taken by means of a universal trolley bar attached to the locomotive.

The total weight of the locomotive is 43,000 lbs., and the speed when delivering 100 H.P. at the draw bar is about five miles per hour. This is sufficient to pull a train of six to eight heavily loaded freight cars on a level, or an aggregate of 200 to 300 tons.

The construction of the locomotive is of the strongest kind. The motor has wrought-iron field magnets, which are belted to magnetic yokes of iron. One of these yokes carries the gearings which support that end of the motor on the axle, while the other yoke is spring supported from the other axle.

This keeps the gears always in line, and meshing correctly with each other, and at the same time provides considerable spring support for the motor.

The gearing is of aluminum bronze pinions and cast wrought-iron gear-wheels. This gearing runs in gear cases, in which a plentiful supply of grease is placed. This decreases the noise, friction and wear.

On the intermediate shaft is keyed a mitis-iron brake drum, which is covered with wood lagging. It is embraced by two half bands of steel, tightened upon it by means of the brake drum lever situated in the operating stand.

The driving wheels are 42 in. in diameter and are steel tired.

The frame consists of two heavy side plates, in which are located the main axle bearings.

The heavy cast-iron end-plates, on which are cast the cow-catchers, are bolted to the side plates by through bolts.

The operating platform is at one end of the main platform, and is railed in and covered with a protecting roof. On this platform are the levers for operating the controlling mechanism, the brake and the sand boxes.

The universal trolley bar extends upward from the locomotive at this place.

The controlling mechanism consists of two large rheostats of the Thomson-Houston railroad type. These are so arranged with their contact shoes that no reversing switch is needed.

The operator so stands that he always faces in the direction in which the locomotive is to go, and being in this position, he pushes the rheostat lever from him to make the locomotive go forward, and pulls it toward him to make it go backward.

A positive center lock is provided, so that in turning the current off there is no danger of passing the neutral point on the rheostat, and so reversing the locomotive with the current on.

When the operator stands in the above-mentioned position he pushes the brake lever from him in order to apply the brake.

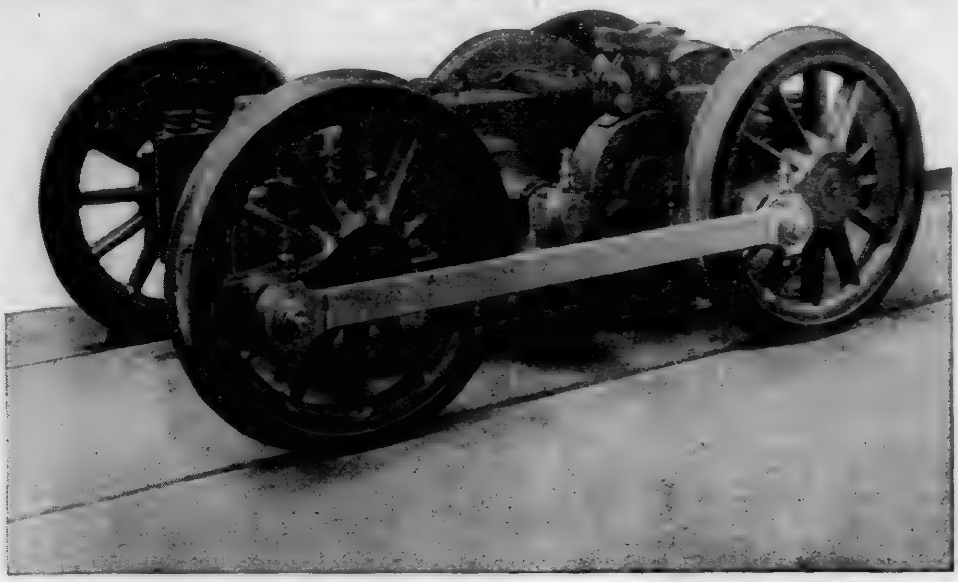
The bands are so arranged on the brake drum that the friction tends to tighten them up more upon the wood lagging, and so assists the operator.

A combined main switch, lightning arrester and fuse box is placed within easy reach of the man, so that he can instantly shut the current off from the locomotive by a single movement of the hand.

The construction of the motor is of the most rigid and waterproof kind, the field spools having their wire enclosed and entirely sewed up in canvas bags, which are covered with a heavy coating of waterproof paint.

Some data on the locomotive are as follows: Voltage of locomotive, 500 volts; power, 100 H.P.; speed on level track, with full load, 5 miles per hour; speed reduction between armature and axle, 1 to 25. The engine is of standard 4 ft. 8½ in. gauge; the drivers are 42 in. in diameter, and the wheel-base 6 ft. 4 in. The length of the platform is 12 ft. 7⅛ in., and the length over all, at the pilots, is 15 ft. 9½ in. The width over all is 7 ft. 0¼ in. The height of the platform above the rail is 4 ft. 4 in. The weight of the locomotive complete, except the trolley-pole, is 42,525 lbs.; the motor weighs 5,400 lbs. It is furnished with sand-boxes and with spring draw-bars of the link-and-pin type.

The machine was designed and built under the supervision of Mr. J. P. B. Fiske, at the company's Lynn factory.



TRUCK OF THOMSON-HOUSTON LOCOMOTIVE.

Foreign Naval Note.

SOME trials recently made at Shoeburyness of compound armor-plates having the face hardened by a new process invented by Captain Tresidder have, it is stated, given better results than have been heretofore attained. The projectiles used were Palliser chilled shot, Holtzer shell and Hadfield steel shot.

The new process seems to have hardened the plate so that the liability of the projectiles to break up without penetrating is increased; but it does not seem to have removed any of the inherent defects of the compound plate as shown in previous trials.

Of the projectiles used, the Hadfield steel showed the best results, and the Palliser chilled shot the poorest. The Holtzer shell did well, but hardly as well as the Hadfield.

New Double-Screw Ferry-Boats.

THE double-screw ferry-boat seems to be finding favor on the Hudson River, and will probably in time replace entirely the old paddle-wheel type. The latest examples are the *Bremen* and the *Hamburg*, now nearly completed for the Hoboken Land & Improvement Company's ferry between Hoboken and New York. The *Bergen*, of that line, was the first double-screw boat, and in the new boats the same type has been followed, with the addition of the upper saloon; in this following the example of the Pennsylvania Railroad Company, as shown in the *Cincinnati*, which was described last month.

The hulls of the new boats are of steel, and have been built at the yard of T. S. Marvel & Company, at Newburg, N. Y. The dimensions are: Length over all, 222 ft.; length on water-line, 218 ft. 6 in.; breadth over guards, 62 ft.; beam of hull, 35 ft.; depth, 17 ft.; draft, 11 ft. As stated above, the boats are double-decked. The upper saloon is 97 ft. long by 36 ft. wide and 10 ft. high. It has a promenade hood extending all around it, butting against the pilot houses, giving the whole a pleasing appearance. The lower saloons are 157 ft. long, with an average width of 15 ft.; height, 13 ft. A double stairway leads from each lower saloon to the upper one. The total seating capacity in each boat is 450 persons.

Instead of one triple-expansion engine, like the *Bergen*, these boats have each two compound engines of the vertical inverted type. The engines have been built by the W. & A. Fletcher Company, of New York. The cylinders are 20 in. and 36 in. in diameter and 28 in. stroke. The cranks in each engine are set opposite to each other, and when the engines are coupled the center line of the cranks in one is at right angles with the other, so that on the shaft there are four cranks 90° apart. The shaft runs the whole length of the boat, with a propeller on each end. The air and circulating pumps are driven by an independent compound engine, with cylinders 7 in. and 14 in. in diameter and 16 in. stroke. There are two air-pumps, 17½ in. × 14 in. cylinders, and one double-acting circulating pump 17 in. × 16 in. cylinder.

Steam is furnished by two boilers, each 9 ft. 1 in. in diameter and 21 ft. long; each has two corrugated furnaces 44 in. in diameter, the total grate surface being 100 sq. ft. The working pressure will be 125 lbs. in regular service.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page 570, Vol. LXV.*)

CHAPTER XIII.—(*Continued.*)

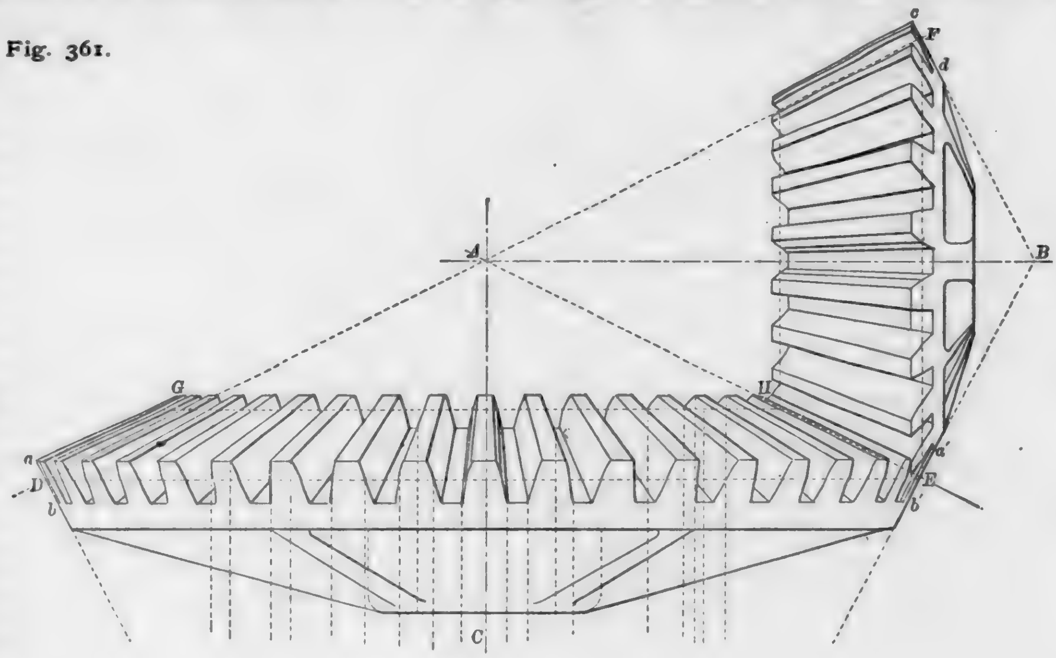
PROJECTION OF A BEVEL WHEEL AND PINION IN GEAR.

Figs. 360 to 364 represent a bevel wheel with 40 teeth geared into a pinion with 20 teeth, the pitch being 2 in. Fig. 360 represents a section through the center of the wheel and of the pinion ; fig. 361 a side view ; fig. 362 a plan, and fig. 363 a view looking at the side of the wheel and at the end of the pinion.

Let *A B* and *A C*, fig. 360, be the axes of the pinion and wheel, and *D E* and *F E* the projections of their major pitch circles. The teeth are laid off in the same way as has been described for laying them off in the section of miter gears.

To draw a side view, the center lines, pitch circles and pitch cones are drawn as shown by dotted lines in fig. 361. Then to lay off the teeth it will be necessary first to draw a plan, fig. 362, and from this project the teeth in the same way as was explained for drawing a miter gear. If the different views are not on the same sheet or not in such relation to each other as to permit the projection of the teeth from the plan to other views, as is the case with figs. 362 and 363, these lines—as *a' a*, *E D* and *b' b*, fig. 362, corresponding to *a a'*, *D E* and *b b'* of fig. 361—should be drawn in pencil, and the points of the teeth can then be projected to them, as indicated by dotted lines in fig. 362. Then take the distance of each point of intersection, as 1, 1, 2, 2, 3, 3, etc., of the projection lines with *a a'*, *D E* and *b b'*, from the center line *K A B* with a pair of dividers, and transfer it to the corresponding line in the end view, fig. 363. It is of course more convenient to draw the plan immediately above or below the end view ; but in some cases it is not possible to place the views in such relation to each other. This is the case with the three views of the pinion shown in figs. 361, 362 and 363. In fig. 361 the teeth might be projected from the end view of

Fig. 361.



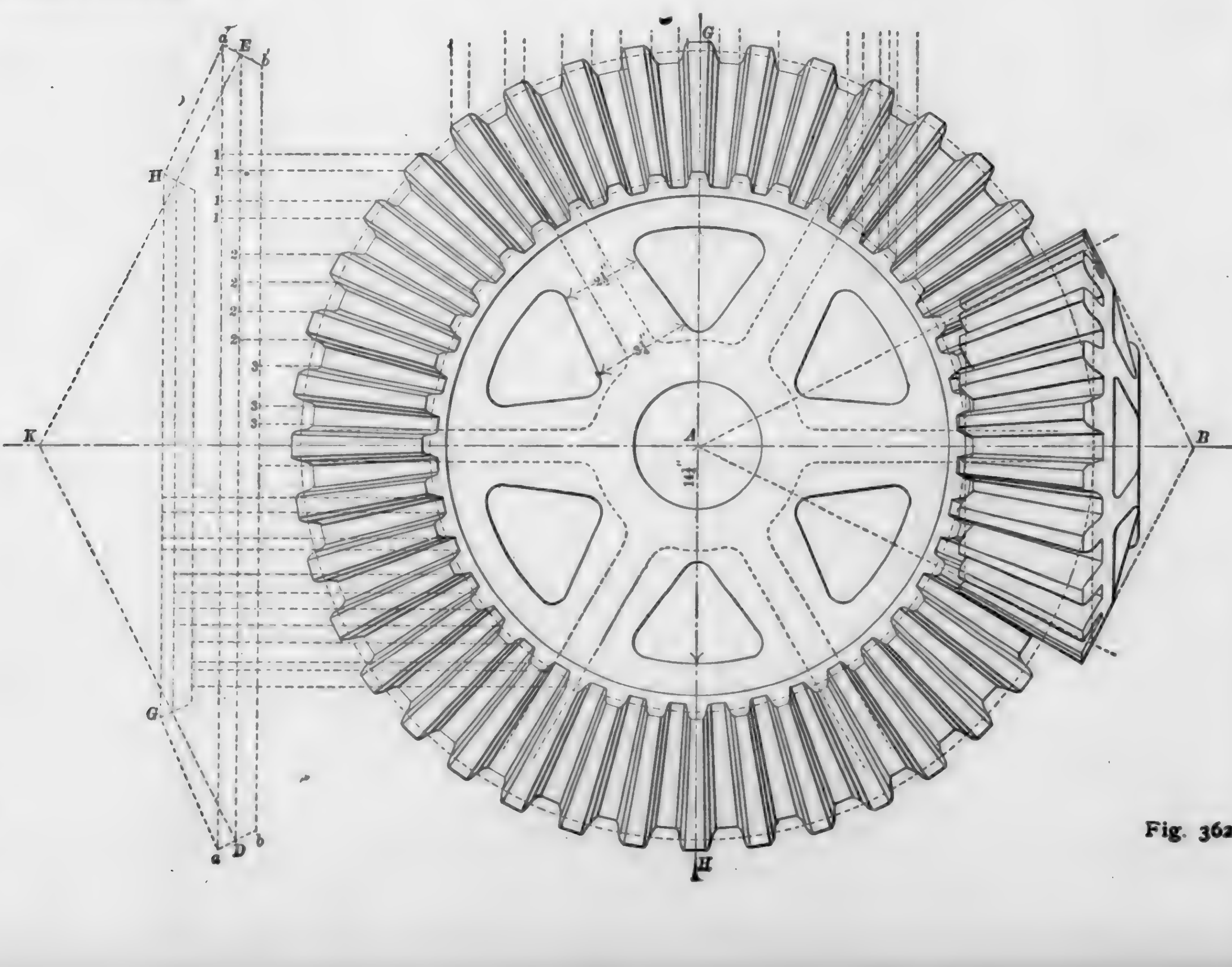


Fig. 362.

the pinion shown in fig. 363. Obviously, if the plan is placed in such a position that the teeth of the pinion can be projected from its end view to both fig. 361 and fig. 363, then it would be impossible to project the teeth of the wheel from its plan to the side view, fig. 361. Therefore a plan or side view (or possibly both) of the pinion should be drawn in pencil in fig. 363, as indicated by dotted lines, to which the teeth can be projected, and the points thus determined can then be transferred to the appropriate views with a pair of dividers.

In drawing a wheel and pinion in gear with each other it will be difficult to represent the teeth in the side view, fig. 361, which mesh into each other in their proper relation without an end view which will show this. It is therefore best to draw a back view of the pinion showing the teeth of the pinion and wheel, which are engaged together as represented in fig. 364, as a guide in drawing the side view. They may be laid down in pencil and rubbed out when the side view is inked in.

The student will find that drawing a pair of bevel wheels correctly is quite a difficult problem, which requires a good deal of skill. The examples given should be drawn either half or full size, as a beginner will find it less difficult to draw such wheels on a large scale than it is to represent them as small as they are shown in the engravings.

In practice drawings of bevel wheels are seldom completed in all their details, as doing so involves a great deal of time and labor. Ordinarily only the pitch cones, the rim, arms and hub of the wheel and a few teeth are shown.

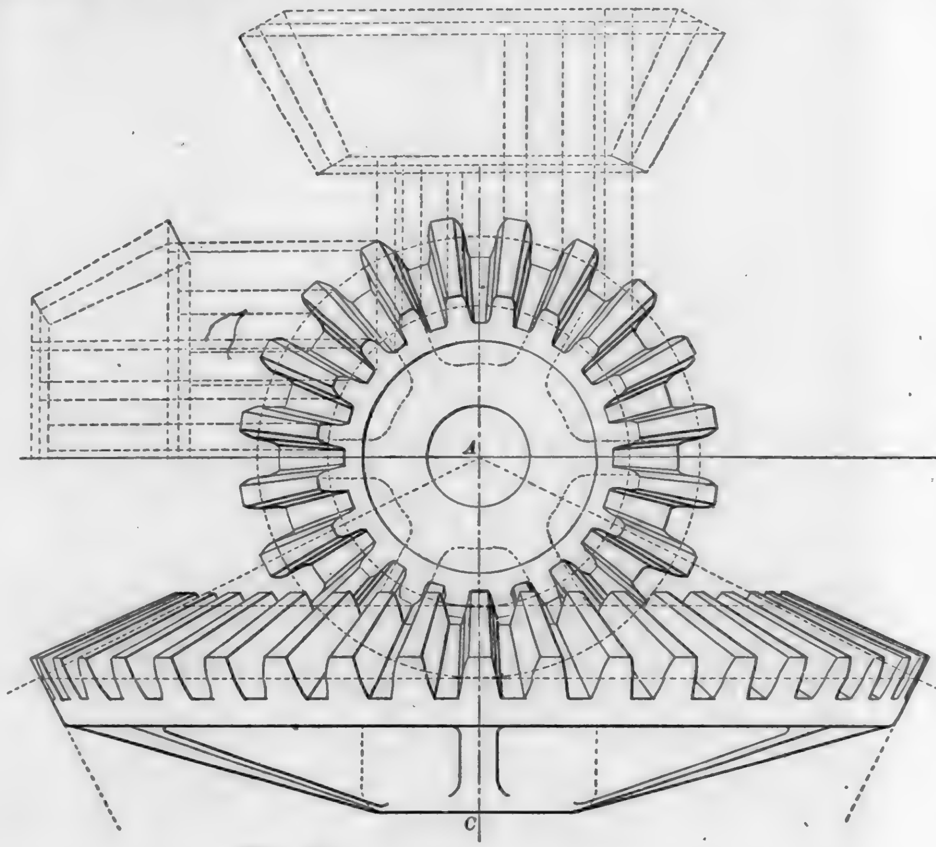


Fig. 363.

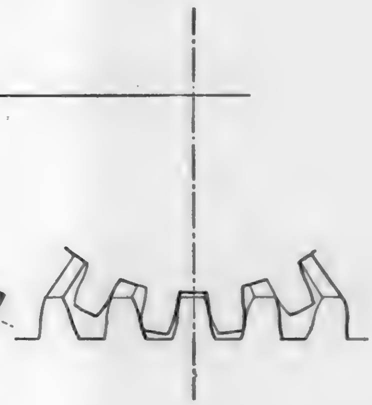


Fig. 364.

Fig. 365 represents a section of a bevel wheel and pinion whose axes, $S\ K$ and $S\ B$, stand at an angle of 60 degrees to each other instead of being at right angles, as in the previous examples. The wheel has 48 teeth and the pinion 24 of 2-in. pitch. The diameter of the major pitch circle of the wheel is, therefore, $30\frac{9}{16}$, and that of the pinion $15\frac{9}{32}$ in. To draw the wheels, first lay down their axes or center lines $S\ K$ and $S\ B$ at the required angle $K\ S\ B$ to each other. Then lay off on each side of $S\ K$ distances $C\ D$ and $C\ E$ = half of the pitch diameter, and draw lines $a\ b$ and $c\ d$ parallel to $S\ K$. Do the same thing for the pinion, and draw $e\ f$ and $g\ h$. Then from E, the point of intersection, draw lines $E\ D$ perpendicular to $S\ K$ and $E\ F$ perpendicular to $S\ B$; then $E\ D$ and $E\ F$ will be the major pitch diameters from which the primitive pitch cones $D\ S\ E$ and $E\ S\ F$ may be drawn. The remaining parts of the wheel may then be laid off in

Fig. 360.

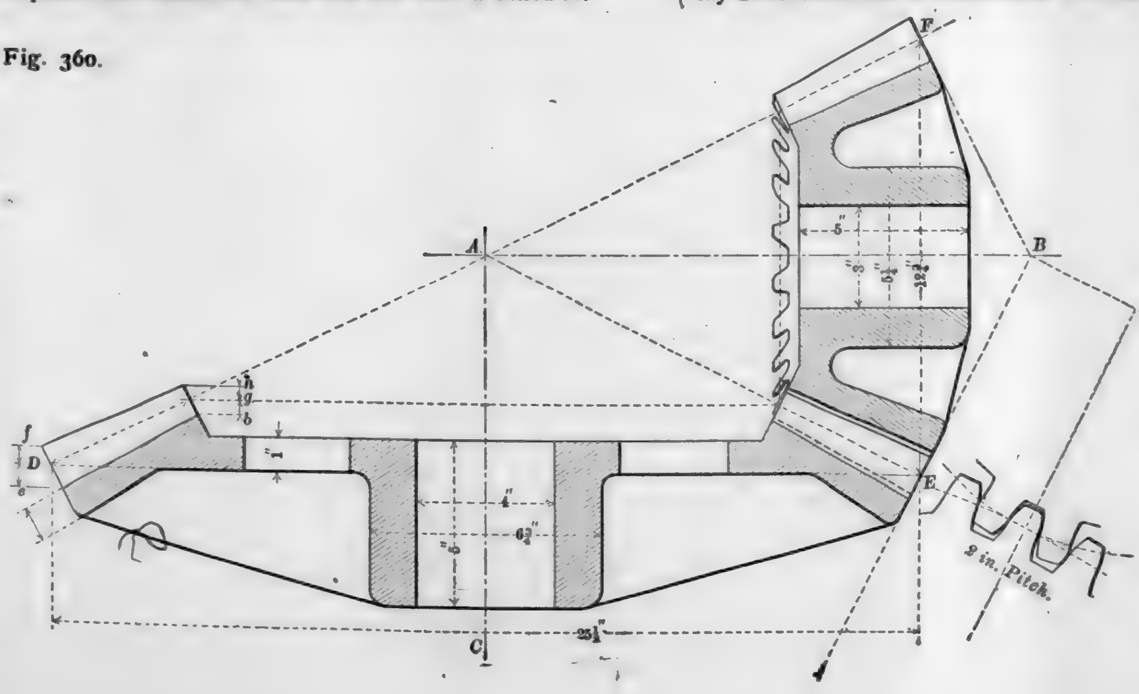
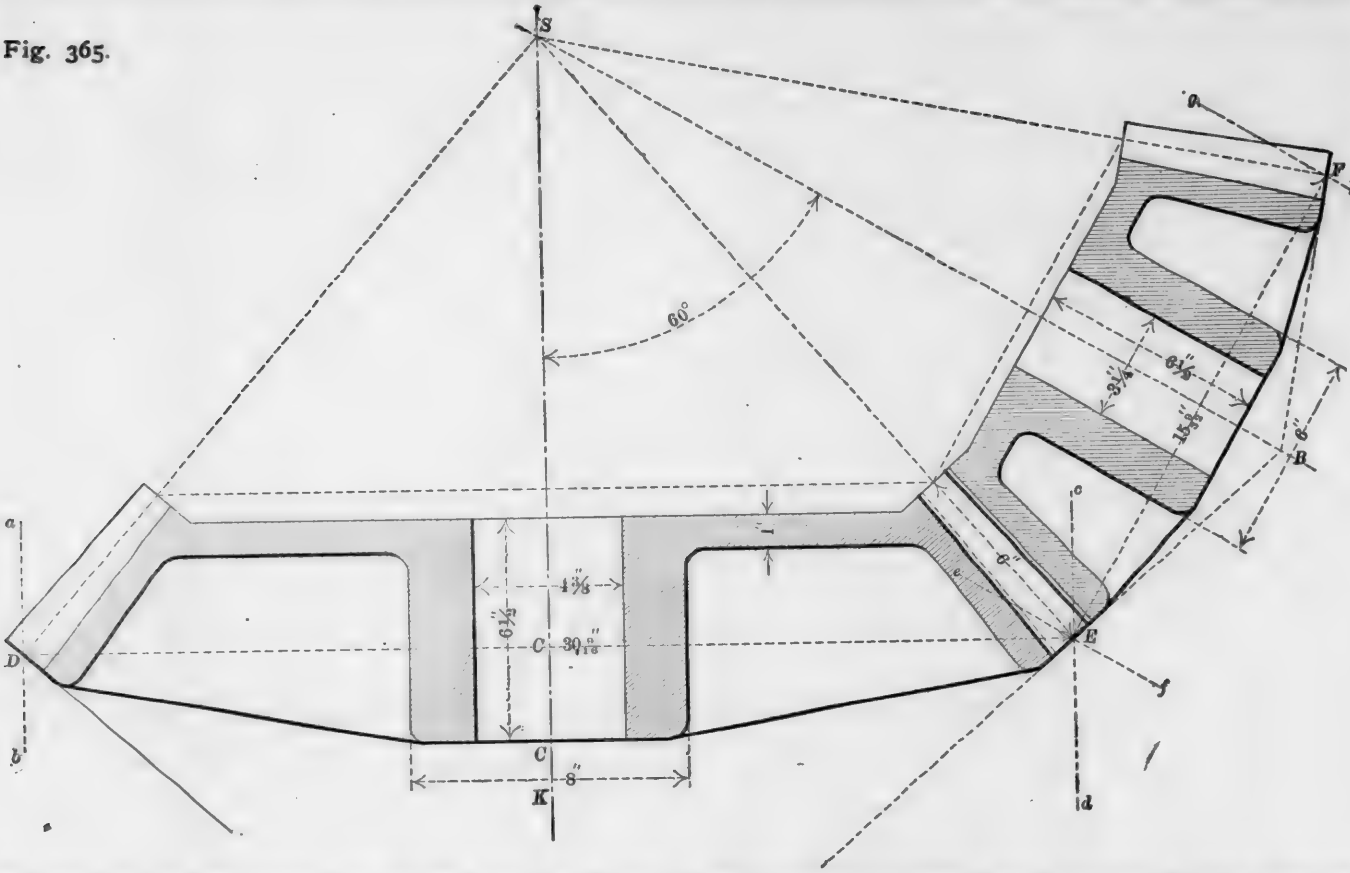


Fig. 365.



the same way as described for wheels whose axes are at right angles to each other.

Fig. 366 represents a pair of wheels whose axes are at an angle of 135 degrees to each other. The method of drawing such a pair of wheels will be sufficiently obvious from the preceding explanations.

OBLIQUE PROJECTION OF A BEVEL PINION.*

Let the pinion be, in the first instance, regarded as situated in a position parallel to the vertical plane, and construct accordingly its projections at figs. 367 and 368. Then transfer the edge view to fig. 370, giving to the axis $S\ O'$ the required inclination to a vertical or horizontal line; and project upon the horizontal center line AB of fig. 369 the vertices O, O', S of the various cones employed to determine the direction and construction of the teeth. The teeth themselves are then to be projected upon fig. 370 in the manner already described in reference to spur wheels, observing that all their rectilinear edges converge toward the point S, while the outlines of the planes (which are, in this instance, radial lines) tend toward O and O' respectively, according as they are situated upon the exterior or interior cones, between which the length of the teeth is comprised.

SCREW GEARING.

The most common form of screw gearing is that in which the shafts are at right angles, and a screw of one thread, or some-

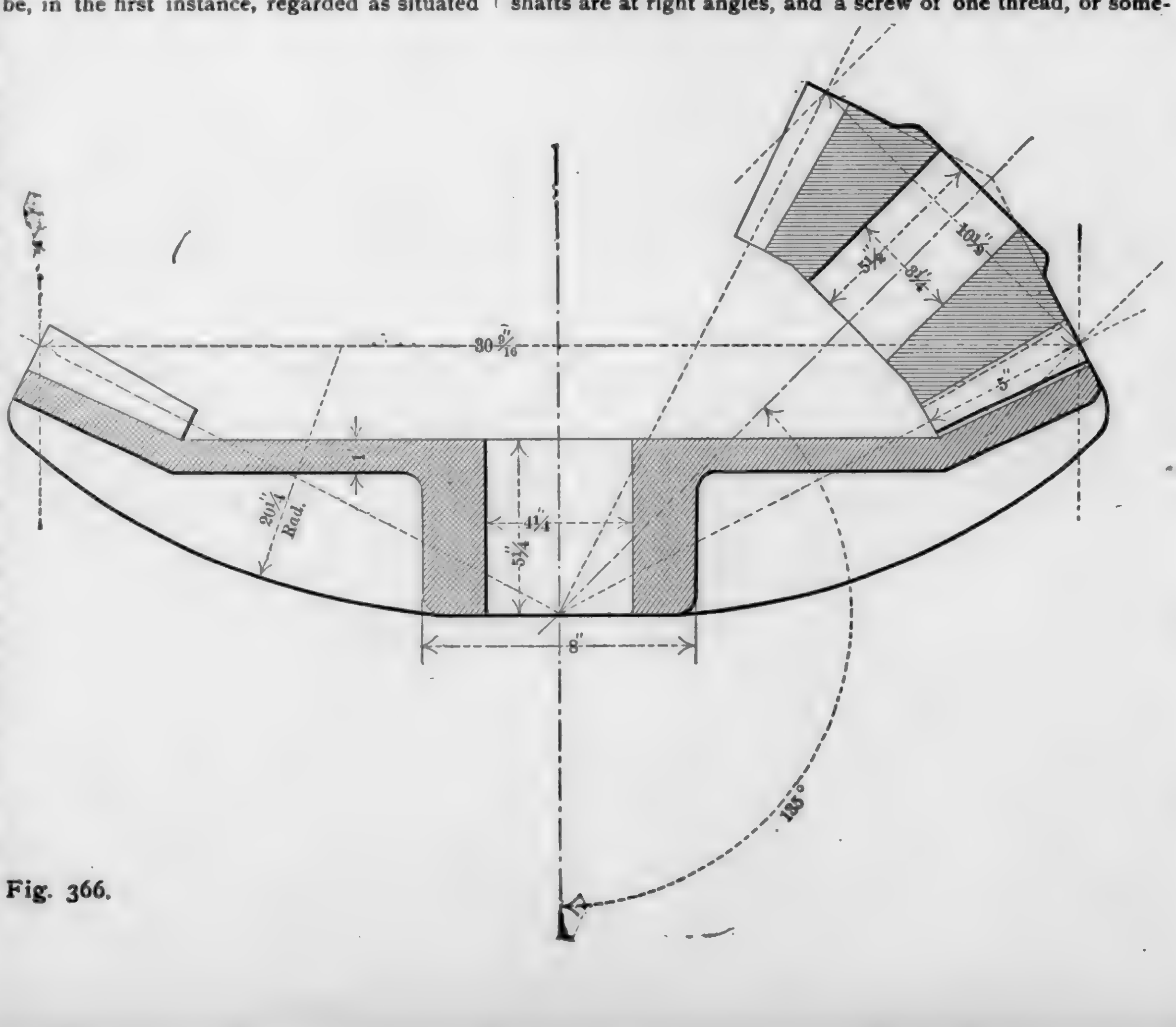


Fig. 366.

* The following explanation and the engravings illustrating it are taken from the "Engineer and Machinists' Drawing-Book."

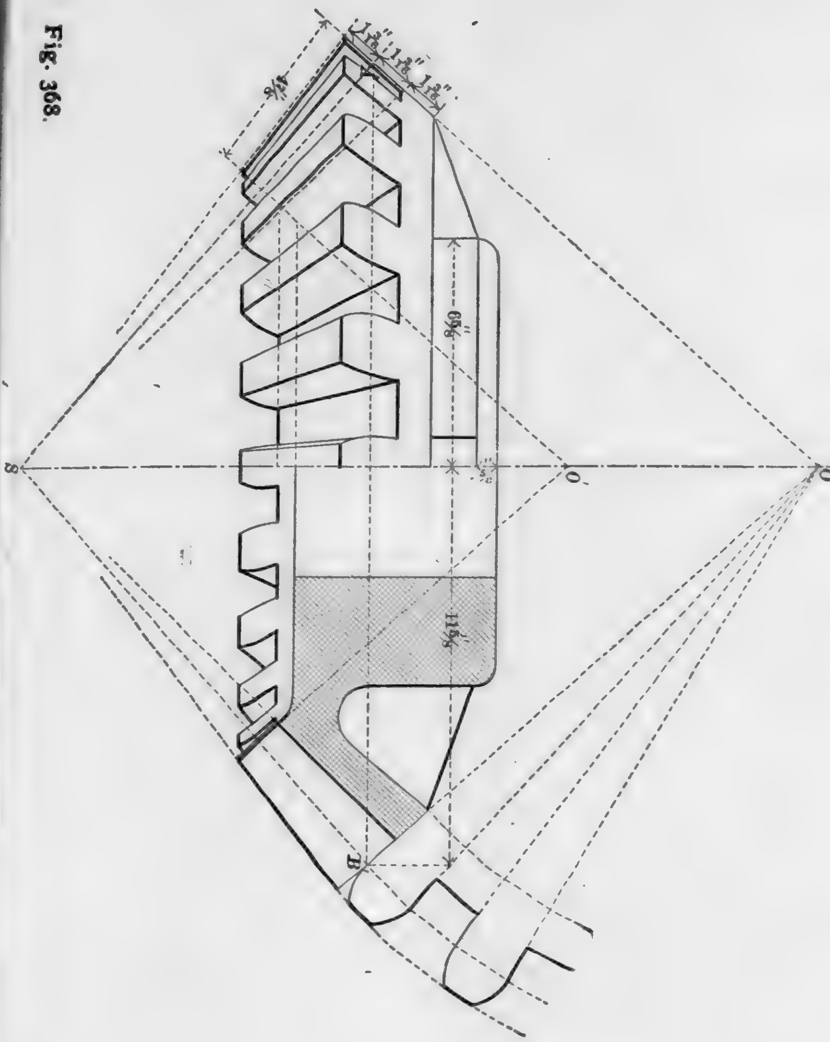


Fig. 368.

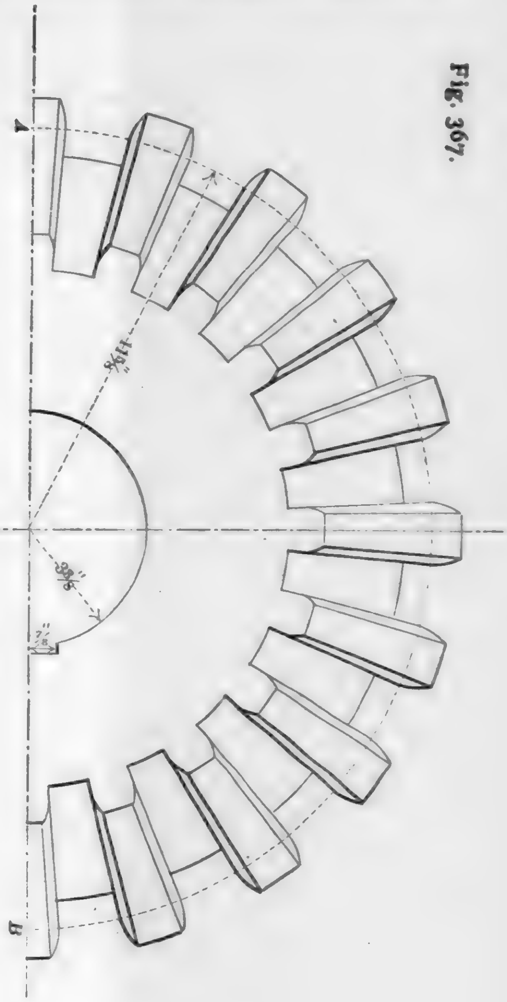


Fig. 367.

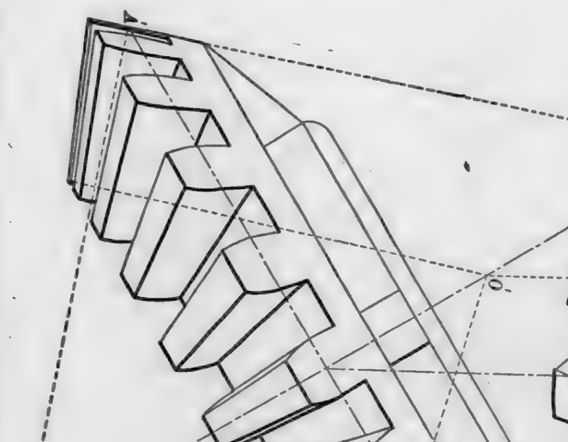


Fig. 370.

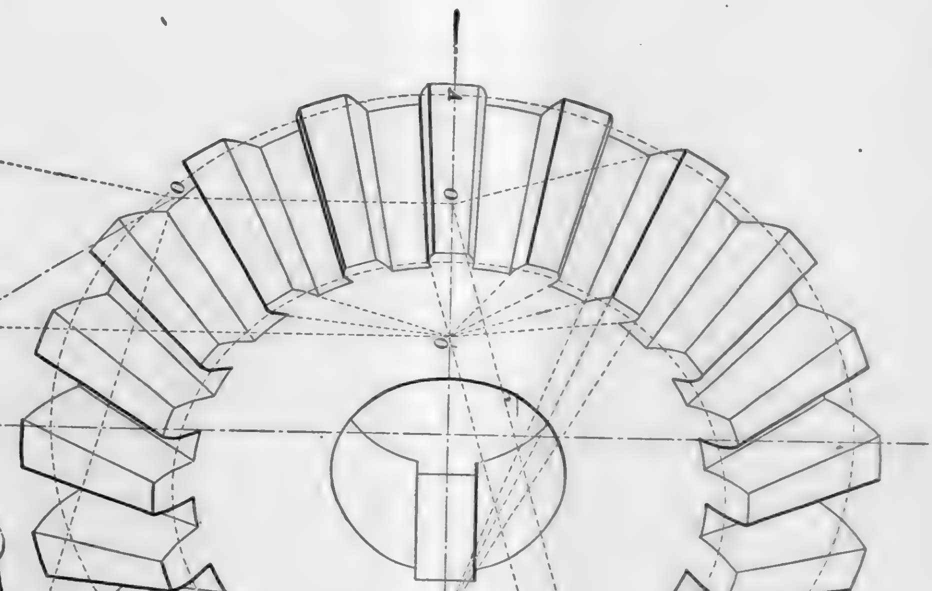


Fig. 369.

times of two or three threads, works with a wheel of many teeth. Then the screw is often called a *worm* and the wheel a *worm wheel.* With this arrangement a great difference in the velocity of the screw and wheel is obtained, for the reason that for one revolution of the screw, if it is single threaded, the wheel is moved a distance equal to the pitch of its teeth, or equal to one tooth and its space. If the screw is double or treble threaded the wheel is moved two or three teeth for one

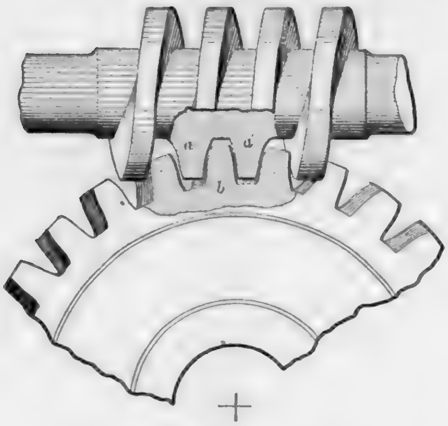


Fig. 371.

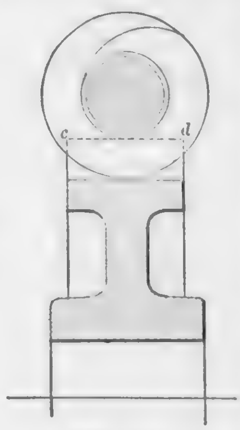


Fig. 372.

revolution of the worm. A much greater difference in the force which can be exerted is possible with screw gearing of given dimensions than with a spur wheel. A spur wheel, to produce the same difference would have to be at least ten times as large as a worm wheel. Screw gearing is commonly so con-

Fig. 373.

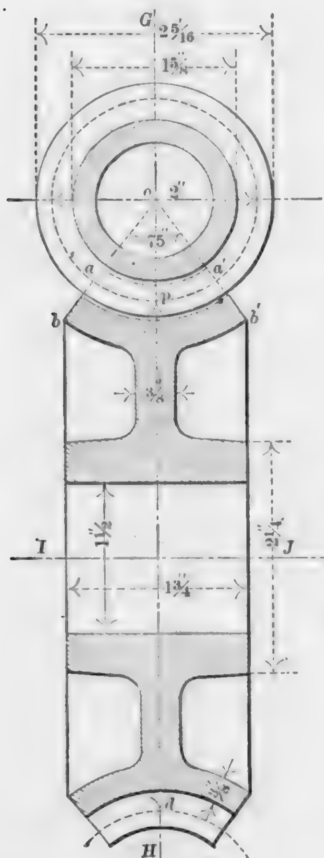
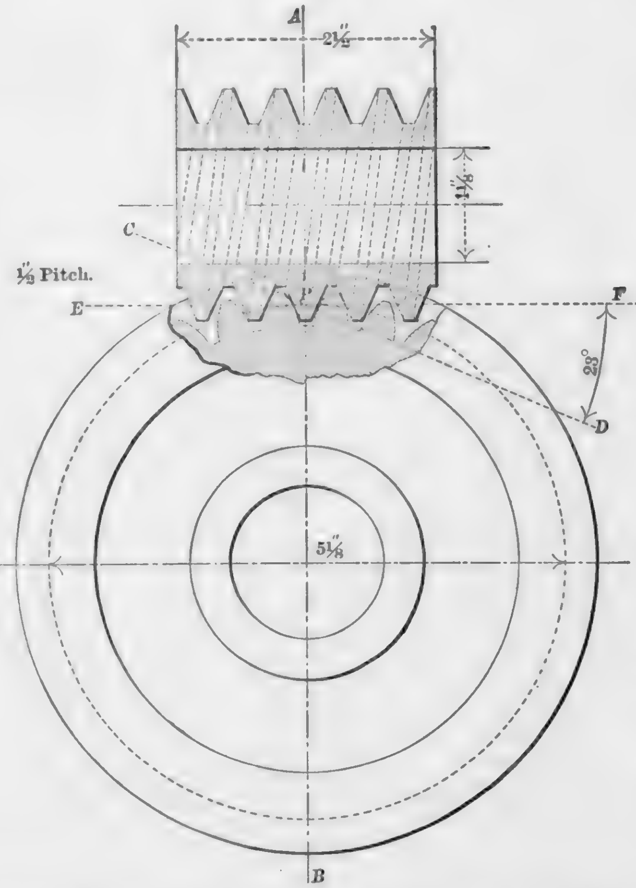


Fig. 374.



structed that the worm or screw will drive the wheel, but the wheel will not drive the worm. This is often advantageous, as in a windlass for hoisting weights and other forms of mechanism, because the gearing remains stationary in any position it may be in after being moved.

If a worm wheel is geared into a single-threaded screw the pitch of the teeth of the wheel is equal to the pitch of the thread of the screw. If the latter is double or treble threaded its pitch is two or three times that of the teeth of the wheel. Single-threaded screws will be considered first.

Figs. 371 and 372* show a wheel and single-threaded worm. A part of the threads at *a a'* and the adjoining teeth of the wheel are shown in section on a line through the center of the worm. From this it will be seen that the relation of the wheel to tne worm or screw is the same as that of a rack and pinion, and the teeth of the wheel and the threads of the screw may therefore be drawn in the same way as those for a rack and pinion. Fig. 373 represents a transverse section of a worm and gear drawn on a plane, *A B*, of fig. 374, at right angles to the axis of the worm and parallel and through that of the wheel. Fig. 374 is a side view of the wheel, the worm and the adjoining teeth of the wheel being shown in section.

From fig. 372 it will be seen that the form of the rim of the wheel is rectangular. The teeth of the wheels are inclined on the face so as to coincide with the position of the thread of the screw. In fig. 373 the rim of the wheel is curved in section so as to coincide with the form of the worm, the teeth being beveled on their sides as shown at *a b* and *a' b'*.

To make a drawing representing a section of a worm and wheel, the pitch and the number of teeth of the wheel being given, first lay down a center line, *G H*. Then, having calculated the diameter of the pitch circle, lay it off on *G H* from the axis *I J* of the wheel. The pitch diameter of a worm is usually four or five times the pitch. From *p*, the pitch point, lay off *p o* half the diameter of the worm. Then from *p* lay off the height and depth of the teeth, as for spur wheels. The tips and roots of the screw and the section of the teeth may then be drawn from the center *o*. The sides of the teeth may be drawn by laying off angles *b o p* and *b' o p* from the center *o*; *o b* and *o b'* will then define the outlines of the sides of the teeth. The wheel represented in fig. 374 has involute teeth, which are drawn in the same way as for a spur wheel; and the section of the thread of the screw is the same as that for a rack, and can be drawn in the same way, *C D* being the line of action, which is laid off at an angle of 23 degrees to the pitch line *E F* of the

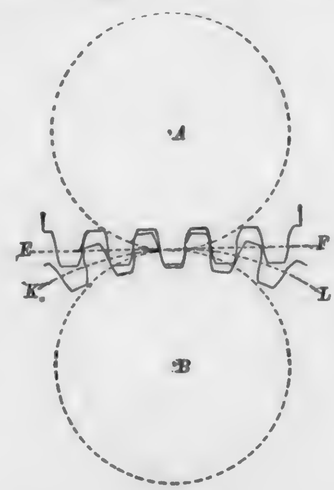


Fig. 375.

screw, and is drawn through the pitch point *P*. The base circle of the wheel is drawn tangent to the line of action, and in this instance coincides with the root circle of the teeth. The form of the sides of the threads are straight lines perpendicular to *C D*.

If cycloidal teeth are used, the outlines of the teeth of the wheel are described by points in generating circles *A* and *B*, fig. 375, rolling within and without the pitch circle *K L* of the wheel, and the outline of the thread of the worm by the same circles rolling on its pitch line, *E F*.

It has been pointed out that if the section of the teeth of a worm wheel on a plane through and parallel with their axes, be made like that of a spur wheel of the same radius and pitch, and the threads of the worm like the teeth of a rack suitable for working with such a spur wheel, the worm and wheel will gear correctly together so far as contact in that plane is concerned. It has commonly been assumed and acted on that all radial sections of the worm threads must be of the form so fixed, which

* From Unwin's "Elements of Machine Design."

is right and necessary ; and also that all sections of the worm wheel teeth on sections parallel to the plane referred to should be similar, which is unnecessary, and gives a bad form of worm wheel teeth. If that proceeding is adopted, the worm wheel teeth become merely twisted spur wheel teeth, which only touch the worm teeth at a point in the median plane. The point of contact moves from root to point of the teeth along the intersection of the median plane with the tooth ; the rest of the surface of the tooth is never in contact at all, and the whole of the pressure and wear is concentrated at a single line on the face of the tooth. It is probably in part due to this imperfect construction of the worm wheel that screw gearing owes its bad reputation for friction and rapid wear.*

For these reasons the teeth of screw gears are now cut with a hob, which is shown in fig. 375, being a steel piece on which the thread is cut with the same tool with which the threads of the worm are cut. The steel threads are then grooved longitudinally to the axis of the screw and hardened. The teeth of the wheel are first cut as nearly to the finished form as practicable. The hob and wheel are then mounted upon shafts and the hob is placed in mesh with the wheel. The hob is now made to rotate, and is dropped deeper into the wheel at each revolution of the wheel until the teeth are finished. The hob usually drives the worm wheel, but sometimes the machine on which the teeth are cut is arranged to drive both the hob and the wheel. Teeth cut in this way are counterparts of the thread of the worm, and consequently have more wearing surface and last longer than those which do not conform to the shape of the screw which drives them. Tools and machines of this kind are manufactured by the Brown & Sharpe Manufacturing Company, of Providence, R. I.†

Those who wish to study the subject of gearing and extend their information concerning it may find some or all of the following books useful :

Weisbach's "Mechanics of Engineering and Machinery ;" Professor Willis's "Principles of Mechanism ;" Professor Rankine's "Machinery and Mill Work ;" Moseley's "Mechanics of Engineering ;" Professor MacCord's "Kinematics ;" Beale's "Practical Treatise on Gearing ;" Professor Reuleaux's "Konstrukture ;" Professor Klein's "Elements of Machine Design ;" "Mill Gearing," by Thomas Box ; "Elementary Mechanism," by Professors Stahl and Woods ; "Elements of Machine Design," by W. C. Unwin (eleventh edition) ; "Practical Treatise on Gearing," by the Brown & Sharpe Manufacturing Company ; "Odontics, or the Theory and Practice of the Teeth of Gears," by George B. Grant ; "A Treatise on Toothed Gearing," by I. H. Cromwell ; "Senior Course in Mechanical Drawing," by William H. Thorne.

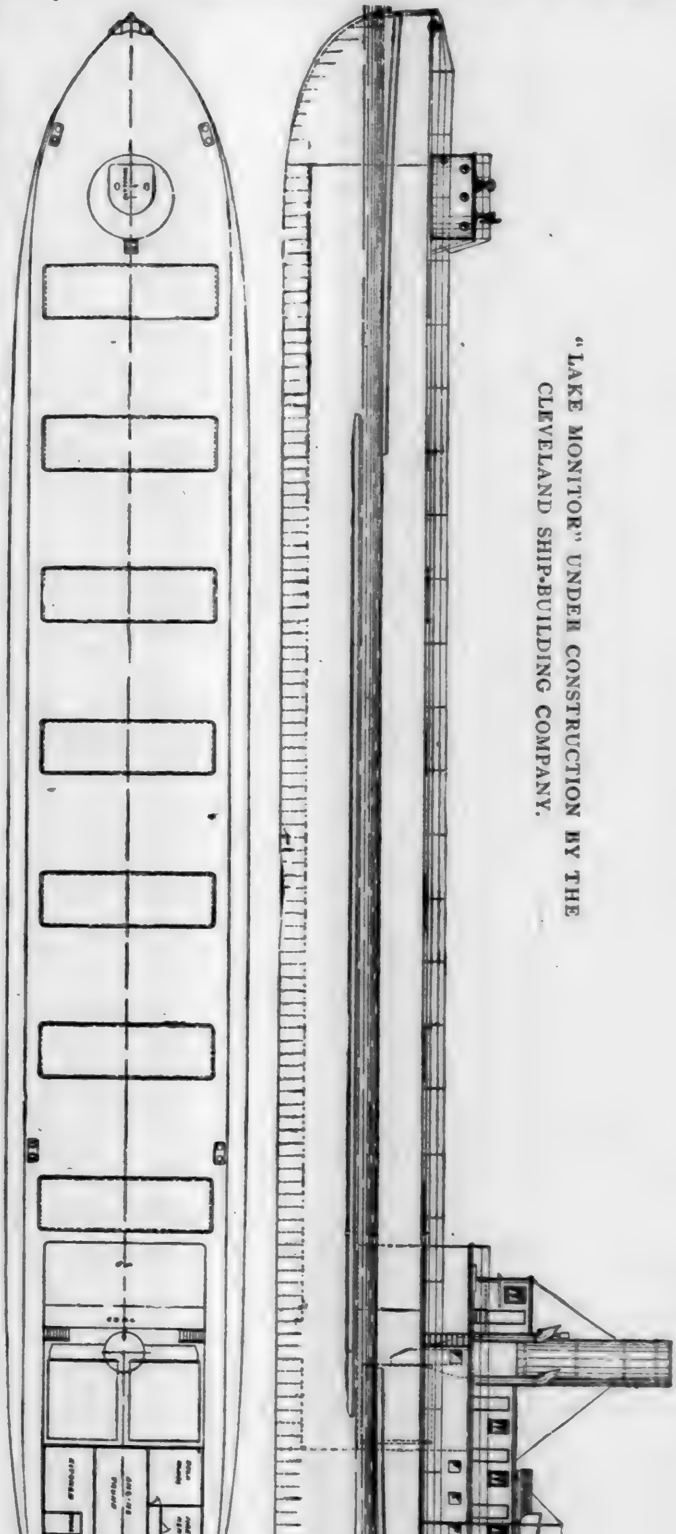
Lake Monitors.

(From the Cleveland *Marine Review*.)

In the contracts let a few days ago to the Cleveland Ship Building Company, by Mr. J. S. Fay, Jr., of the Lake Superior Iron Company, for two steel boats styled "Lake Monitors," another wide departure from the ordinary lake freight carrier is recorded, and the *Review* presents in the accompanying engravings the main features of the plans for the new boats. In brief it may be said that the monitor, as introduced by the Cleveland Company, will have an upper or outside deck with rounded sides and no lower deck, and will have but one bulkhead, the collision bulkhead forward. The familiar pilot-house and quarters for officers forward, as well as the turtle-back now common to lake steamers, will all be dispensed with, and in their stead a simple turret will be built for the windlass and for steering purposes in the rivers or during fine weather.

A reduction in cost as compared with the present type of steel vessel and increased carrying capacity are main features in the construction of the monitors, and there is little doubt that more of them will be contracted for before the opening of another season.

In the plans presented here it will be noticed that the bow is somewhat cut away. This was at the request of the owners, who look to speed being improved by such a bow, but the builders and others who favor the new type of boat prefer the ordinary straight bow and forefoot. The water bottom will be 4½ ft. deep, divided into six compartments, and the boat's sides will be strengthened by large belt frames. The main structure supporting pilot-house and cabins aft, and also containing quarters for some of the crew itself, will be built up of steel and will have no doors, the windows being small, high up and well secured. The boat will be the same size as the *Wawatam* and *Griffin* of the Lake Superior Iron Company's fleet—266 ft. long, 38 ft. beam, and 23 ft. hold—but is expected to carry as much as the first two boats built for the company, the *La Salle* and *Joliet*, the lines of which are not as fine as those of the *Wawatam* and *Griffin*. The engines and boilers will also be



"LAKE MONITOR" UNDER CONSTRUCTION BY THE CLEVELAND SHIP-BUILDING COMPANY.

duplicates of those in the *Wawatam* and *Griffin*. The cylinders are 17 in., 29 in. and 43 in. in diameter and 36 in. stroke ; the boilers are 11 ft. 6 in. in diameter and 12 ft. long. It was not at first intended to give the boats masts, but they will have two pole spars.

* This paragraph is from Unwin's "Elements of Machine Design."

† From "A Practical Treatise on Gearing," by the Brown & Sharpe Mfg. Co.

Manufactures.

The Commingler System of Car Heating.

THE accompanying illustrations show the apparatus used by the Consolidated Car-Heating Company with hot water circulation, which has been called the "commingler" system. It is claimed that this apparatus has a large capacity, which is due to the direct action of the steam upon the water of circulation, caused by the steam discharging within the body of the water itself. The contact of the steam and water takes place within the pear-shaped body of the commingler proper, a sectional view of which is shown in fig. 1. The flow of steam is broken into hundreds of small jets within a body of quartz pebbles, in such a manner as to silently force the water through the commingler after imparting to it the entire heat of the steam. It is claimed that by giving the proper form and direction to the steam jets within the commingler a forced as well as a gravity circulation is readily obtained, and it is the addition of this feature of forced circulation which enables the commingler to move the water through such large circuits. Any amount and distribution of piping that may be found desirable can therefore be made in a car, the capacity of the commingler being fully assured.

With this system, it is stated, there is no need of inspection, since the pipes are kept constantly full from the condensation. It can be readily applied to cars already equipped with hot-water apparatus, without the addition of new pipes. There is no danger of the system becoming "air-bound," as the overflow-pipe is connected to the air space within the expansion drum, and thus permits the compressed air to escape as the water of the circulating system expands. No air pressure can therefore be generated within the circulating pipes, and this doubtless accounts for the rapid circulation of water obtained with the improved commingler.

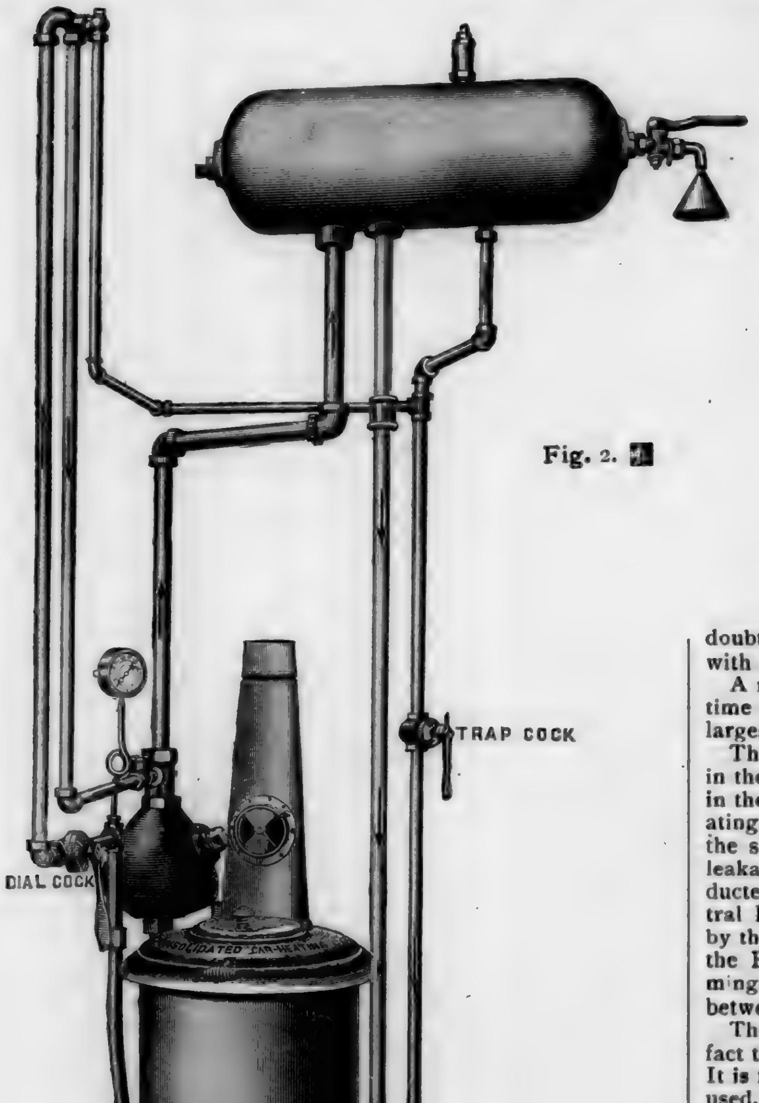
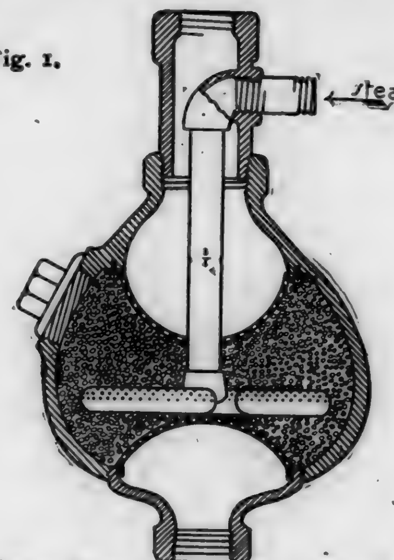


Fig. 2.

Fig. 1.



¼ Size Section through Commingler B

A record of tests presented states that 13 minutes is all the time required to obtain a complete circulation in even the largest cars.

The Consolidated Company states that 5 lbs. steam pressure in the train-pipe at the car is sufficient to heat the largest car in the coldest weather. The small pressure required for operating this system has practical value in increasing the life of the steam hose and in the increased safety and freedom from leakage at the connections between cars. Experiments conducted last year under the supervision of the New York Central Railroad showed that circulation was rapidly established by the commingler with 1¼ lbs. *of steam*, and in connection with the Pennsylvania Railroad return system the improved commingler has worked *in vacuum* with only a difference of 2 lbs. between the supply and return pipe.

The simplicity and ease of management is evident from the fact that the heating apparatus is controlled by only one valve. It is further simplified by the fact that no thermostatic trap is used, or any other device requiring frequent adjustment or liable to get out of order. No part of the apparatus is placed under the car where it is liable to freeze. Every part, as will be seen from fig. 2, is within the car where it can be reached while the train is in motion.

It is claimed that the heating capacity of the commingler is several times as great as that of any water heater, and it is capable of heating several cars by a single water circuit could they be properly connected together. As an instance of what can be done by the commingler, the circuit in the Whitehall tunnel ditches on the Delaware & Hudson Railroad, where one commingler circulates water through over 2,000 ft. of pipe and keeps the ditches free from ice in the coldest winter weather; and in the Albany Electric Railroad car-house there are some very long commingler circulations. It is also true that the amount of heat can be regulated to meet the requirements of the mildest weather where artificial heat is used.

It is the practice of railroads to store cars when not in service by placing them upon side tracks in yards or in car-houses, where in cold weather fire must be kept alive to prevent freezing of the water within the heating pipes. With the improved

commingler system the drain cock can be opened and all pipes emptied before the car is laid up. The car then stands cold and without any danger to the empty pipes of the heating system. When the car is again brought into service, steam is turned into the pipes through the commingler, and the car is at first heated with direct steam. The drain cocks being closed, the water of condensation collects in the pipes until the system is filled with water and circulation automatically takes place. It is thus changed to a hot-water circulating system without the slightest care or attention on the part of the trainman having it in charge. In cold weather the pipes are filled within two hours after steam is turned on, and in the mean time the car has been heated with direct steam. Men having charge of cars when not in service will appreciate the great advantage thus obtained by the use of this apparatus.

These advantages are also found in the Consolidated Company's commingler storage system, which operates a water circulation without a water heater. The addition of the Consolidated automatic temperature regulator to the improved commingler or the commingler storage system makes a very complete equipment.

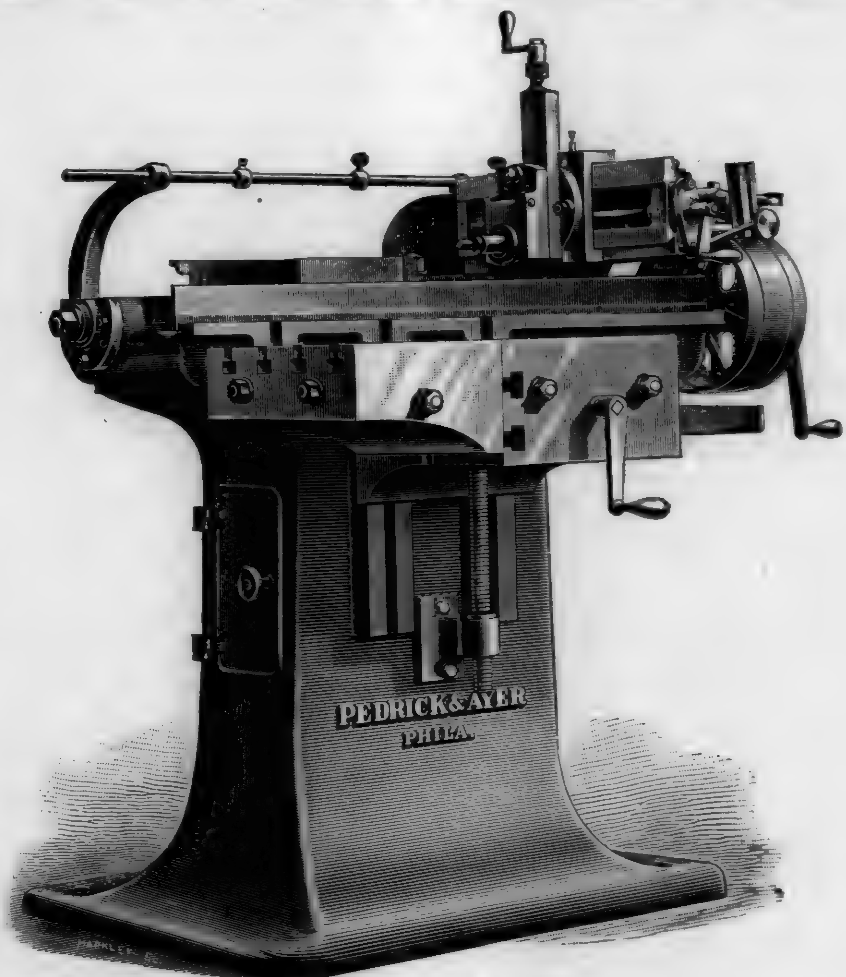
A Standard Shaper.

THE engraving herewith shows a new pattern of standard shaper made by the firm of Pedrick & Ayer, of Philadelphia.

This machine planes 12 in. wide and 30 in. long. It is a column machine, with an adjusting table 14½ in. long and 14½ in. wide, and an auxiliary table 11 in. long to bolt to same when a longer table is desired. This smaller table takes off and leaves an angle-plate to bolt long pieces against the table proper. This table is raised and lowered by a crank and screw with gibs, that carry it true in its upward and downward travel. The arm that travels and carries the cutting tool is designed to resist all cutting strains, and as true work is done at outer end of arm as close to the column. The tool slide has a downward feed by hand of 6 in., and a cross-feed by power; it is on a swivel base and angle work can be planed. The machine is driven by 12-in. pulleys and a 2-in. double-thread screw to the desired cutting speed, with a quick return 2½ times as fast as cutting speed. It has a locking device for holding tool slide solid while siding down or doing angular work. On the sliding head, in front of the operator, is a light cast-iron cover that forms a tool shelf for keeping the cutting tools; on the square tables there is another shelf for wrenches, oil-can, waste, etc., both being convenient and useful. This machine will do any kind of work that can be done on the ordinary ram shaper, and good true surface work also. It is particularly valuable for cutting key-ways in the center of long shafts. No chuck is required, as the column forms one side of a chuck, with jaws any desired depth, by lowering the table and using dogs and screw points and clamping against it.

The tool is always cutting at the same speed whether on long or short work. Not varying speed at all points of travel, as is the case with crank movements, the screw gives the tool a regular smooth cutting speed, producing the finest kind of a surface on all metals; water cuts on iron or steel can be taken, and as good results obtained as with water turning done on a lathe. The stroke of the machine can be altered while the machine is running and readily adjusted; very short cuts can be taken. The belt runs at high speed with positive cams operating the belt shifters, enabling the machine to work up to a line either way. All bearings are self-oiling and are bushed with bronze; all loose pulleys are self-oiling, with bronze bushings; counter-shaft has self-oiling bearings, and pulleys are nicely balanced. All gibs are of wedge pattern, forced, and held by two nuts or studs, allowing fine adjustment and all metal surface. The screw passes through two bronze nuts that are made in duplicate, and can be furnished at small cost.

The machine is so constructed that there is absolutely no spring to the arm when cutting out at the extreme end, as in this position the cutting tool hugs the guides tighter, and will not gauge in or raise up. This is a valuable tool for tool-room or general shop use. It is intended to take the place of a 25-in. or 30-in. old style shaper.



A NEW STANDARD SHAPER.

Brake Beam Patents.

THE following notice from Mr. George W. Payson, General Counsel of the Western Railroad Association, was recently sent out by order of the Executive Committee:

"We are advised by counsel that the claim above (National Brake Beam Company) is either wholly invalid, or, if valid at all, that it can only be sustained by giving it a construction so narrow as not to cover the Universal Brake Beam."

An Efficient Governor.

SOME tests were recently made of the efficiency of the Westinghouse compound engine governor, which showed remarkable results. They were made on a Westinghouse compound engine with 18 and 30 × 16-in. cylinders at the power-house of the Federal Street & Pleasant Valley Electric Street Railroad, by C. F. Scott of the Pittsburgh Laboratory of the Westinghouse Company. A special instrument was designed by Mr. Scott, reading to 0.01 per cent. variation of speed and registering every half second.

In electrical railroad work the variations in the load on the engines are very large and very sudden; but from diagrams taken on the special instrument used it appears that the engine changed but 1 per cent. each side of the neutral line representing the time of vibration of the pendulum through a total change of current equivalent to two-thirds of the rated power of the engine. From a similar curve illustrating the action of a governor which depends upon centrifugal force alone for its change of position, as tested by this instrument during moderate changes of load, it appears that after each new load the speed changed nearly 1 per cent. beyond the point at which it should have settled and gradually worked back to the proper place. This governor was perfectly free from obstructing devices; yet it is indicated plainly that adjustment did not even commence until the speed had changed considerably. However, this is not surprising when it is considered that it depends on this variation of speed for the force of adjustment. Indeed the record is not at all a bad one so far as centrifugal governors go, and the extra momentary change of speed would never be

noticed in the average service, but it would be wholly unfit for electric railway work.

In their new compound engine governor, the Westinghouse Machine Company disclaim broadly the originality of the principle of inertia in shaft governing, but insist that they have been the first to so successfully apply the principle, and exhibit in these tests the evidence of the degree of perfection they have secured by the application.

New Steam Pumps.

THE illustration herewith, fig. 1, shows a Deane special pattern pump designed for railroad and mining service. It is provided with a new patent lever valve motion which prevents breakage of any of the parts of the machine when the pump is run at an excessive speed. The piston-rod, water-piston, stuffing-boxes, valve-seats, covers and stems are of composition metal. The water-piston is fitted with patent fibrous packing. These machines are especially designed for hard, continuous service, and they are made with various combinations of steam and water cylinders for heavy or light pressures. This pump, furnished with a boiler and both mounted on the same base, makes a strong, compact and simple apparatus for station service.

Fig. 1.

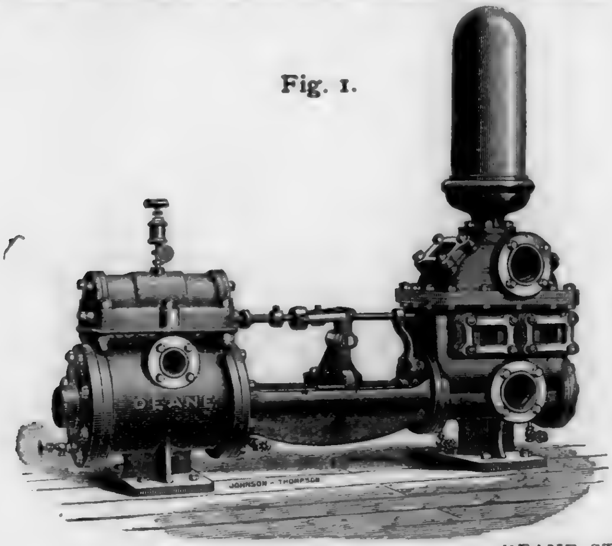
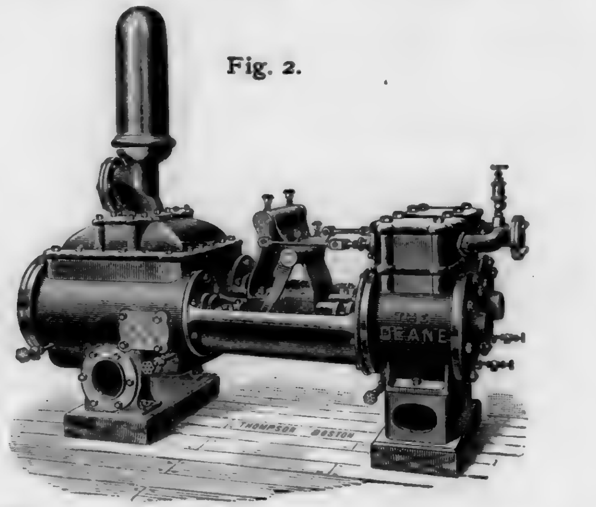


Fig. 2.



DEANE STEAM PUMPS.

Fig. 2 represents the Deane duplex pump. These are constructed from various patterns, and in various proportions suitable for tank service, elevator service, boiler feeding, fire service, etc. In the larger sizes they are particularly adapted for water-works, irrigation, sewage, and other duties where large quantities of fluid are to be handled, the uniform discharge preventing all unnecessary strain on the machine and pipes. The Deane Company has made quite a success of the duplex pumps for elevator service, and has them in operation in many of the largest buildings in the United States.

General Notes.

THE Engineer Department of the United States Army has awarded a contract for water-proofing and preserving the whole of the exterior and interior surfaces, magazines, etc., in fact, all the masonry work of the new gun and mortar batteries at Sandy Hook, New York Harbor, to the Brick & Stone Waterproofing Company, of New York, the work to be done by the Caffall process. This contract has been let after careful investigation, and may be considered as an expert testimony to the value of that process. These works from their position are exceptionally exposed to low temperatures and to the effect of storms.

THE Continental Iron Works, Brooklyn, have a number of orders for corrugated furnaces. The Lake Erie Boiler Works, of Buffalo, recently ordered six, to be used in the new boilers they are constructing for the Metropolitan Elevated Railroad of New York City. Other orders include eight extra large furnaces for J. T. Ryerson & Sons, to be used in the boilers of the new Masonic Temple in Chicago. It may be noted that the boilers of the new steamers of the Cunard Line now building at Fairfield, Scotland, will have 204 corrugated furnaces.

THE Lee Composite Manufacturing Company, New York, has lately received orders for its "slagphalt" paint for passenger car roofs from the New York, Susquehanna & Western, the New York, Ontario & Western, the Delaware & Hudson, the Philadelphia & Reading, the Boston & Albany, the New York, Providence & Boston, the South Carolina and other railroads. It is claimed that this paint will entirely prevent the cutting of roofs by cinders. This company's "Permanence" brand is especially adapted for the roofs of roundhouses and other railroad buildings, as it resists the action of acids and gases.

THE William Cramp & Sons Ship & Engine Company, of Philadelphia, is making extensive changes in its plant, and has placed the contract for a new boiler shop with the Berlin Iron Bridge Company, of East Berlin, Conn. This boiler shop will be constructed entirely of iron and will be composed of two parts, one part 55 ft. in width by 350 ft. in length, made very high between joints on account of moving large marine boilers over each other. This portion of the building is controlled by a 50-ton traveling crane which is to be furnished by William Sellers & Company, of Philadelphia. Connected with this main portion will be a wing 58 ft. wide by 370 ft. long, served the whole length by a 20-ton Sellers traveling crane. The building is constructed entirely of iron from the designs of the Berlin Company, and will be one of the most complete in every detail.

THE Delaware & Hudson Canal Company have adopted the Sewall coupler for all their passenger equipment, and these are now being applied. They have also determined to use the Consolidated Company's automatic temperature regulators on a good portion of their passenger equipment, this regulator having given excellent satisfaction upon the Albany & Troy Belt Line trains.

BY permission of Mr. H. Walter Webb, the Consolidated Car-Heating Company announces that it is equipping 106 new coaches of the New York Central with an improved system of direct steam heat. If this system gives the satisfaction expected, it is to be applied to all new cars built by the Central in 1892 and 1893. The New York Central have also given the Consolidated Company a considerable order for automatic temperature regulators, and these will be applied to cars which will be in service this winter.

THE Detroit Dry Dock Company, in Detroit, Mich., has closed a contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for a new fire-proof machine shop to be used for their engine work. The plant will include two 20-ton electric cranes, and a large number of new tools of the latest patterns. The shop will be 201 × 66 ft., and will be 50 ft. high, the center being all in one story with the cranes so arranged that there will be 38 ft. clear space below them. Three galleries 28 ft. wide will extend the entire length of the main shop, two of them being intended for the lighter tools and the third for pattern work and storage. Plans are also being prepared for a boiler shop of the same style.

THE Cleveland Ship Building Company, Cleveland, O., is building the engines for the launch for the new lighthouse tender *Amaranth*. The boiler is of the Roberts safety water tube pattern.

THE Baldwin Locomotive Works are building 20 compound freight engines for the Philadelphia & Reading Railroad; 10 of them are consolidation engines with cylinders 14 and 24 in. in diameter, and the other 10 are of the same pattern with cylinders 13 in. and 22 in. in diameter, all of them being of the

Vauclain four-cylinder type. These works are also building for the Reading Road a compound locomotive with Wootten fire-box, which is intended especially for speed. The cylinders are 13 and 22 in. in diameter, and the driving-wheels 6 ft. 6 in.; it is to be tried on the Bound Brook Line between New York and Philadelphia.

THE Cleveland City Forge & Iron Company, Cleveland, O., has recently been doing some very heavy work for the new cruisers. This Company made the rudder-frame for the *New York*, and has recently completed another weighing about 17 tons for Cruiser No. 12. Other heavy forgings recently made include an extra shaft for the steamer *Pilgrim* of the Fall River Line, which is 39 ft. 5 in. long, 27 in. in diameter, and weighs 68,200 lbs. finished. The forge has recently been increased in capacity by three new hammers, and an addition 69 ft. × 160 ft. is now under construction.

THE Frontier Iron Works, Detroit, are building four triple-expansion engines for new lake steamers. Two of these are duplicates, with cylinders 20 in., 32 in., and 54 in. by 42 in. stroke. The other two are 23 in., 37 in., and 62 in. in diameter and 44 in. stroke. They are also building two compound stationary engines with cylinders 9 in. and 17 in. by 38 in. stroke.

AT a recent meeting of stockholders of the Lawson Varnish Company, of Chicago, the capital stock was increased from $150,000 to $200,000. As a further indication of the growth and expansion of the business, they have, during the past year, enlarged their factory so that their capacity is doubled.

THE Buffalo Seal & Press Company, Buffalo, N. Y., has just moved into new quarters. This company is now manufacturing at the rate of 87,000,000,000 seals per year, and has lately increased its capacity by new special machinery. Besides supplying over 150 railroads, a contract for 7,000,000 seals for the United States Government was recently taken. The Company's seals have been adopted by the English, German, and Brazilian governments.

A NEW size of hydraulic jack has been added to the list of Watson & Stillman. It is specially designed for lifting parlor cars, has a broad steel base, is 37 in. in height, has 22 in. raise, and a lifting capacity of 30 tons.

THE St. Charles Car Company, St. Charles, Mo., has recently received orders for 200 furniture cars for the Missouri Pacific Railway and 500 box cars for the Atchison, Topeka & Santa Fé. In December the shops turned out 200 box cars for the Fairbanks Beef Company and 300 coal cars of 60,000 lbs. capacity, for the Texas & Pacific. In passenger work the Company has nearly completed 18 out of an order for 30 passenger cars for the Chicago, Burlington & Quincy, and has begun work on an order for the Lake Shore & Michigan Southern.

THE Toledo, St. Louis & Kansas City Railroad has just put in service between Toledo and St. Louis some new chair cars built for the road by the St. Charles Car Company. The interior decoration is very neat and tasteful, and the fitting and furnishing are very handsome; the interior finish is in mahogany throughout. The cars are 56 ft. long, and will seat 40 persons. At one end is the ladies' toilet-room, Baker heater and linen locker. At the other there is a handsome smoking-room, a lavatory for gentlemen, and a conveniently arranged buffet from which hot and cold refreshments can be served. A snug little sofa is fitted in front of the buffet, and the remaining space is given up to Scarritt reclining chairs with adjustable tables between.

Baltimore Notes.

NOTWITHSTANDING the difficulties encountered in tunneling under Howard Street, incident to sewers and quicksand, the construction of the Belt Railroad is being pushed forward rapidly. Howard Street is on a bed of quicksand. Two of the city sewers have been seriously damaged, and, owing to the nature of the soil, iron pipe will be substituted for the brick work in making repairs. It is thought that by September, 1892, the Belt Line will be in full operation, when the Baltimore & Ohio Railroad will abandon the Locust Point Ferry so far as passenger and freight traffic for points north of Baltimore are concerned.

THE South Baltimore Car Works, Curtis Bay, are building a sample 34-ft. inside measure lumber box car, of a lot of 1,000 cars to be operated by the West Virginia & Pittsburgh and the Baltimore & Ohio roads in the lumber trade; 500 of the cars will be built at Curtis Bay and 500 at Pullman.

THE West Virginia & Pittsburgh road, which is being extended from Bealington, W. Va., will connect with the Grafton & Greenbrier Railroad at Philippi, W. Va. The Grafton & Greenbrier is a narrow-gauge road, but will be widened to standard gauge upon completion of the extension of the West Virginia & Pittsburgh to Philippi.

THE Baltimore & Ohio is extending the State Line road from Uniontown, on the Fayette County Branch, to Morgantown, W. Va., at which point connection will be made with the Fairmont & Morgantown Branch.

IT is stated that upon completion of the extensions of the Philadelphia & Reading, the Western Maryland and the West Virginia railroads, to connect with the Baltimore & Ohio main line at Cherry Run, 65 miles east of Cumberland, a Union station will be put up at that point, plans for which are now being considered.

CONTRACTS for most of the supplies to be used in constructing the new South Baltimore & Curtis Bay Electric Railroad have been awarded, and the work of laying ties will begin in a few days. The electric equipment and overhead wires will be furnished by the Edison General Electric Company of New York. The Armington & Simms Company, of Providence, R. I., has the contract for the engines and boilers. The order for the cars has not yet been placed.

THE South Baltimore Car Works, Curtis Bay, are building 1,000 coal cars of 60,000 lbs. capacity for the George's Creek Coal & Iron Company.

THE Baltimore & Ohio's machine, boiler and blacksmith shops at 58th Street, Philadelphia, were completely destroyed by fire November 6; estimated loss, $10,000.

THE Baltimore & Ohio's new electric light plant and power house at Brunswick, Md., were also destroyed by fire November 9; the loss will approximate $10,000.

THE South Baltimore Car Works and the Ryan & McDonald Manufacturing Company, Curtis Bay, are in the market for electric light plants for their respective shops.

IT is rumored that the Baltimore & Ohio Company will shortly be in the market for a number of passenger, freight and switching engines.

THE Baldwin Locomotive Works have arranged with the Baltimore & Ohio Railroad to make a test of a new compound ten-wheel engine, built for fast express service.

THE Baltimore & Ohio Railroad Company has bought the interests of the Georgetown Railroad, Dock, Elevator & Barge Company, in Georgetown, D. C. The purchase is important, as it gives the Baltimore & Ohio an entrance into Georgetown by means of the Georgetown Railroad. This road is about one mile long, of standard gauge, and runs into the business section of Georgetown. It will be used by the Baltimore & Ohio in connection with the Metropolitan Southern, now being constructed to effect a Southern connection. The Metropolitan Southern commences at Linden Station, on the Metropolitan Branch in Montgomery County, Md., and runs to the Potomac River, about eight miles. The Potomac will be bridged at or near Great Falls, and the extension will be continued in Virginia to unite with the Virginia Midland at Fairfax Station. By the purchase of the Georgetown Railroad, and the building of a short line from a point near the Aqueduct Bridge to connect with that road, an entrance to Georgetown will be effected.

PERSONALS.

J. C. HILL has been re-elected Railroad Commissioner of Virginia for another term.

LOUIS J. BARBOT has been re-elected City Engineer of Charleston, S. C., for another term.

W. M. HUGHES has been appointed Bridge Engineer in the Engineering Department of the city of Chicago.

GEORGE T. MARSH has been appointed Superintendent of the works of the Baltimore Foundry Company at Curtis Bay.

Sir C. GZOWSKI, for several years past President of the Canadian Society of Civil Engineers, has declined a re-election to that office.

PROFESSOR PALMER C. RICKETTS, of the Rensselaer Polytechnic Institute, has been appointed Chief of Engineers of the New York State National Guard.

J. H. AGNEW has resigned his position as Superintendent of the South Carolina Railroad, after holding it for a year. He was previously Master Mechanic of the road.

W. H. MILLER has been appointed Superintendent of Motive Power of the Chicago & Eastern Illinois Railroad. He was recently on the Columbus, Hocking Valley & Toledo.

ALBAN EAVENSON has been appointed Acting Chemist of the Lehigh Valley Railroad, in place of C. P. COLEMAN, who has been transferred to the General Superintendent's office.

P. F. BRENDLINGER and FRANK NEARING, forming the engineering firm of Brendlinger & Nearing, have recently removed their offices from Buffalo, N. Y., to New York City.

HON. D. B. CULBERSON, of Texas, who was mentioned as the successor of the late Walter L. Bragg on the Interstate Commerce Commission, has declined the appointment, preferring to remain in Congress.

GEORGE H. BAKER succeeds Mr. ANGUS SINCLAIR as Editor of the *National Car & Locomotive Builder*. Mr. Baker has had much practical railroad experience, and many opportunities of learning what railroad men want to read. He is well qualified to maintain the excellent standard of the *Car-Builder*.

OBITUARY.

L. HART SELDEN, who died in Chicago, December 9, was born in Hadlyme, Conn., and educated as a civil engineer. He was connected with several lines in the East, and afterward located the Erie & Pittsburgh Railroad in Pennsylvania. He had charge of the building of the Peninsular Railroad—now part of the Chicago & Northwestern—from Escanaba to Marquette, and of some other roads in the Northwest. For some years past he has had a large practice as a consulting engineer.

MAJOR GEORGE W. MCKEE, U. S. A., who died in Philadelphia, November 30, graduated from West Point in 1863, and was appointed Lieutenant in the Ordnance Corps. He was promoted to be Captain in 1874, and Major in 1882. For some time past he had been in command of the Frankford Arsenal. Major McKee was considered one of the best ordnance officers in the Army, and was noted for his scientific attainments. He made some valuable reports and investigations for the Department.

WILLIAM C. ALLISON, who died in Philadelphia, November 30, was born in Chester County, Pa., and at an early age established himself in business as a wagon builder in Philadelphia. After following this with varying success for a number of years, he formed a partnership with John Murphy, and the firm of Murphy & Allison erected extensive shops on Market Street in Philadelphia, where they built a large number of railroad cars. In 1856 the Girard Tube Works were added to this establishment, and ten years later the firm was dissolved by the death of Mr. Murphy, when Mr. Allison formed the firm of W. C. Allison & Sons, which continued until 1881, when the Allison Manufacturing Company was organized with Mr. Allison as president, an office which he continued to hold until his death.

COLONEL WILLIAM E. MERRILL, United States Engineers, died suddenly December 14, while on his way from Cincinnati to St. Louis in an Ohio & Mississippi train. He was 66 years old, and was born in Wisconsin; he was appointed a cadet at West Point from that State, and graduated in 1859. He served through the war in the Engineer Corps, and had been steadily at work ever since, rising gradually to the rank of colonel, and holding many important positions. In 1878 he was sent to Europe to study the application of movable dams in river improvement. For some time past he had been in charge of improvements on the Ohio River and its tributaries. Colonel Merrill's standing as an engineer was very high; he was author of several works on engineering and of many papers for technical societies of which he was a member.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, November 18, a written discussion by Rudolph Hering on Mr. Rafter's paper on the Rochester Water Works was read.

A paper on the Rolling Friction in Operating the Draw of the Thames River Bridge, by A. P. Boller, Jr., and H. J. Schumacher, was read and briefly discussed by members present. The discussion was continued until the next meeting.

AT the regular monthly meeting, December 2, Mr. J. A. L. Waddell read a paper on some disputed points in Railroad Bridge Designing, taking a strong position in favor of uniform loads, and assuming ample loads in proportioning bridges. The paper was discussed at considerable length by members present.

The following candidates were declared elected: *Members*, Daniel B. Dunn, Macon, Ga.; F. P. Spalding, Washington; James W. Way, St. Louis, Mo.

Associate Members: George G. Earl, Americus, Ga.; Oscar Erlandsen, Poughkeepsie, N. Y.; George T. Richards, Pittsburgh, Pa.; William W. Thayer, Philadelphia, Pa.

Master Mechanics' Association.—Secretary Sinclair gives notice that the only one of the Boston Fund Scholarships in the Stevens Institute of Technology which has so far been awarded is to Mr. George P. Hodgman, son of Mr. S. A. Hodgman, of Wilmington, Del., who is now a student in the institution. Mr. Sinclair will be much pleased to supply information to others who desire to apply for any of these scholarships.

The Committee on Uniform Statements of Locomotive Performance have issued a circular submitting a number of questions to members as to their methods in making our performance sheets, the allowances made and the manner in which mileage is accorded, fuel, oil, etc. This subject is one of importance, and members will do well to answer as soon as possible. The Chairman of the Committee is Mr. George F. Wilson, Superintendent Motive Power, Chicago, Rock Island & Pacific Railroad, and his address is Chicago, Ill.

Engineering Association of the South.—The annual meeting was held in Nashville, Tenn., November 12. The Treasurer submitted his report, showing that the Society was in a prosperous condition, with a balance on hand. The Secretary reported that there were at present 100 members, 3 associate and to junior members. Nine meetings were held last year, at which 12 papers were read. The following new members were elected: Lucian S. Johnson, Peach Orchard, Ky.; John K. Peebles, Nashville, Tenn.

The President then delivered his annual address, including an exhibit of the principal features of industrial development during the past year and the most striking engineering works of the year.

The following officers were elected for 1892: President, A. V. Gude, Atlanta, Ga.; First Vice-President, James Geddes, Nashville, Tenn.; Second Vice-President, F. P. Clute, South Pittsburgh, Tenn.; Secretary, Olin H. Landreth, Nashville, Tenn.; Treasurer, W. B. Ross, Nashville, Tenn.; Directors, E. C. Lewis, W. L. Dudley, W. F. Foster, Nashville, Tenn.; John McLeod, Louisville, Ky.; Hunter McDonald, Savannah, Ga.; Charles B. Percy, Montgomery, Ala.

American Forestry Association.—The annual meeting was to be held in Washington, December 29 and 30. At this meeting it was expected that some action would be taken to draw the attention of Congress to the necessity of legslation to secure the national forest reservation. A large attendance was expected.

NOTES AND NEWS.

Surveying for a Pacific Cable.—The Coast Survey steamer *Albatross* has completed about half of the survey ordered by Congress for a cable from San Francisco to Honolulu. A line of soundings run from San Francisco direct showed the existence of a plateau extending out about 60 miles, with an average depth of 100 fathoms; but at that point there is a sudden drop to 1,200 fathoms, proving the existence of a submarine precipice.

The California coast is generally rocky, and there are few good places for landing a cable. The best found is at Salinas, on the Bay of Monterey, where there is a long stretch of clear, sandy beach, free from stones and rocky projections.

An American Electrical Carriage.—An electrical carriage, invented by William Morrison, of Des Moines, Ia., has been for some time in daily use in that city, and is described by the *Electrical World*, which says that it will soon be taken to Chicago. The carriage itself is of ordinary pattern, with three seats, and will carry six persons. The motor is placed on the rear axle, power being furnished by 24 accumulator cells placed under the seats. The winding of the motor is so arranged that a reversal of the current will cause the carriage to run backward. The steering apparatus is simple and effective.

An Electrical Carriage.—A French electrician, M. de Graffigny, has been experimenting with a tricycle driven by an electric motor, the power for the motor being derived from storage batteries. The tricycle was of the Rudge make, with rubber tires, and the motor was attached directly to the main axle. The storage battery used was a simplification of the

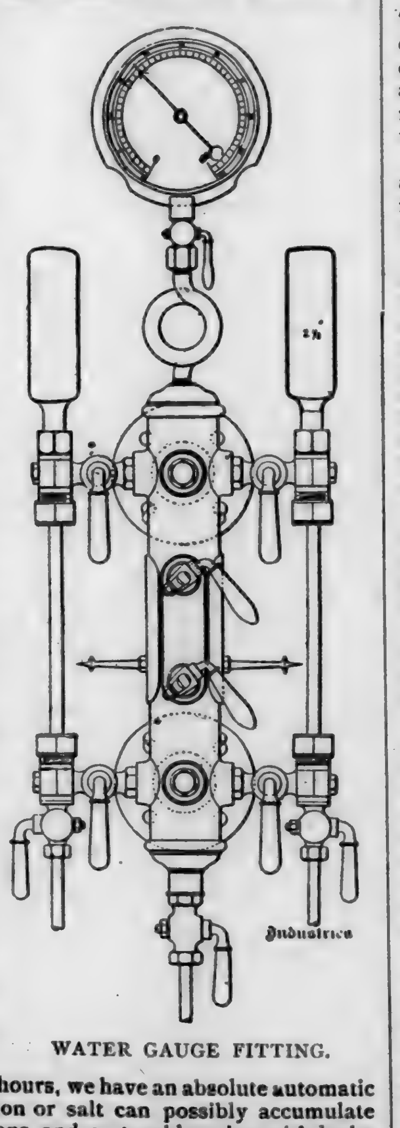
Renard battery; it had 36 elements. The motor used was of the Gramme type. The total weight of the vehicle ready for a start was: Carriage, 73.3 lbs.; storage battery, 47.9; motor and gearing, 33.1; baggage, fresh acid for batteries, etc., 15.4; driver, 138.9; total, 308.6 lbs.

With this carriage a speed was attained of 28 miles an hour on a descending grade, 13¾ miles on a level and 6½ miles on a heavy up grade. A run of 57½ miles was made without recharging the battery. The cost of running was about 20 cents an hour for the time actually spent on the road.

A New Swiss Mountain Railroad.—A new cable railroad has just been completed up the Rotthorn near the Lake of Brienz, in Switzerland, the summit of which is 7,757 ft. above the sea. The actual ascent from the lower to the upper terminus is 5,510 ft., or 220 ft. more than the Pilatus Railroad, which has heretofore been the highest of these mountain roads. The maximum grade on the new road is 25 per cent.; the works included to tunnels and numerous small bridges.

Water Gauge Fittings for Boilers.—Mr. Thomas Urquhart, Locomotive Superintendent of the Grasi-Tsaritzin Railroad in Russia, writes to *Industries* as follows:

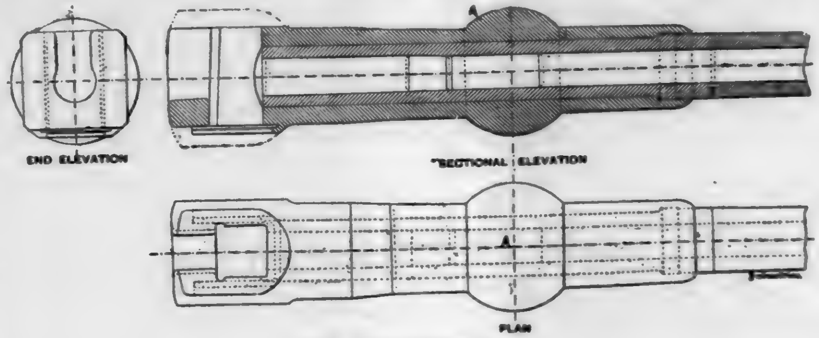
"Undoubtedly false water levels, in a great many cases, end in explosion of boilers or collapse of flues, and investigation generally ends with the conclusion that neither explosion nor collapse would have taken place had the water-gauge connections with the boiler been kept clear of incrustation. According to the old maxim that 'prevention is better than cure,' I beg to bring before the notice of your readers the accompanying illustration of a simple and efficient device in connection with water-gauge mountings used on the Continent, and with which I have had some experience. This apparatus completely obviates the formation of incrustation in the lower connections between glass-gauges and boilers, even with feed water of the worst quality.



WATER GAUGE FITTING.

"A glance at the annexed illustration will explain the action of the anti-incrustator. Each of the steam chambers, composed of pieces of boiler tubing, is placed directly over the glass tubes, with which they are always in communication. These have a total cooling surface of 100 sq. in. By their condensing action they keep up a constant supply of pure water to the gauge glasses, and set up through their connections a return current to the boiler. In some exact experiments which we made, these two steam chambers, placed on the gauge glasses of a Galloway boiler having a stokehole temperature of 100° Fahr. and a working pressure of 5 atmospheres, steam was condensed at the rate of 5.74 oz. per hour with the *liquid fuel* used on the Grazi-Tsaritsin Railroad, giving an evaporation of 12 lbs. per lb. of fuel. Thus we arrive at the fact that, with a sacrifice of fuel of ½ lb. per day of 12½ hours, we have an absolute automatic guarantee that no incrustation or salt can possibly accumulate in the lower gauge connections, and no trouble exists with leaky cocks which become so by incrustation. This small sacrifice of fuel is a very low premium for the great security effected, and ought to commend itself to steam users on sea and land."

The Adamson Gun.—The illustrations given herewith represent a sectional elevation, end view and plan respectively of a gun invented by the late Mr. Daniel Adamson, and which is



THE ADAMSON GUN.

being introduced by the Adamson Gun Syndicate of London. The principal feature of this type of gun consists in abolishing the trunnions and substituting therefor a ball joint, *A*, or spherical enlargement, which works in a suitable socket on the gun carriage. The advantage claimed for this arrangement is that the gun can be readily trained to cover a much greater range without moving the carriage.

The gun from which our illustrations are taken was made at Bofors, in Sweden, and has been tested by Swedish artillerists with the following results: The gun was fired five times in 20 seconds. An elevation of 25° was found to carry the projectile 26,250 ft., or nearly five miles. Eighty-five rounds were fired with excellent results.

The gun tested was 3.36 in. in caliber and 98.43 in. in length. The rifling has 24 grooves 0.295 in. wide and 0.039 in. in depth; the width of the lands is 0.138 in. The volume of the chamber is 161.72 cub. in. The projectile weighs 14.77 lbs., and the charge of black powder 5.51 lbs. With black powder a muzzle velocity of 1,920 ft. was attained, which was increased to 1,970 ft. with smokeless powder.

The claims made for this gun are that it has great strength and durability with respect to its weight, and that the mechanism is simple and easy to manage, and does not require experts for its handling.

An Iceland Bridge.—A new suspension bridge, the first of its kind in Iceland, has recently been erected over the River Olrusaa. The bridge is 372 ft. long and 9 ft. wide. All the materials had to be transported on sledges over the ice during the winter from the nearest harbor, Eyrarbakki. Six steel-wire ropes, weighing 5¼ tons each, and 430 ft. long, were carried upon the shoulders of 180 men, and took two days in transport from Eyrarbakki to the site of the bridge, a distance of about nine miles. A great many difficulties had to be surmounted in the construction, as may be imagined in a country where there are no railroads, and hardly any wheeled vehicles.

Sanitary Improvement in Frankfort.—A long and very interesting report by Chief-Engineer Hirsch on the Sanitary Improvement of Frankfort-on-the-Main was recently published in the *Annales des Ponts et Chaussées*, of which only the briefest abstract is given below:

The works, which extended over a period of 20 years, completely transformed the ancient city. The works of sanitary improvement were of three classes: The distribution of water, the carrying off waste water by sewers and the treatment of sewage.

The old water supply being extremely defective, about 1873 a supply was brought by an aqueduct from the Vogelsberg, amounting to an average of 36½ galls. per inhabitant for the day. This supply was completed in 1885 by pumping from a deep water-bearing stratum at Stadtwald, on the left bank of the Main below Frankfort. This water supply, as it is now managed, is profitable, the annual receipts being considerably in excess of the expenses of maintenance and pumping, leaving a considerable amount to be applied as interest on the cost of the water-works.

The system of sewerage has been established on the principle of carrying off together and by the same conduits the waste water, all refuse susceptible of being washed out, the surplus rain water and drainage water. This system is composed of collecting sewers following as nearly as possible the lines of level of the ground, and of secondary sewers built on the lines of greatest fall and at right angles to the river. On either bank these are divided into two systems, the upper and the lower. The large collecting sewers discharge into the Main at a great distance below the city. The flushing and cleaning of the sewers is done by the surplus water, and ventilation is effected by the house discharge-pipes, which form chimneys. Besides

these pipes there are a certain number of special ventilators carried through chimneys built in the towers of the wall surrounding the old city.

The system of carrying all waste to the sewers works very well for the city ; but the people on the river banks below complained of the pollution of the waters, and it was resolved to erect works for purifying the sewage before turning it into the river. As the local circumstances forbid the use of sewage on the soil, the engineers were obliged to have recourse to some plan for mechanical and chemical purification. The works are situated about three miles below the city. The foul water is carried there by the collecting sewers, one of which is carried underneath the Main by a siphon. There are two groups of six settling basins, each group being able to treat in ordinary times about 700,000 cub. ft. per day, and twice that quantity in rainy seasons. In these settling basins the heavier matters held in suspension are deposited, and from the basins the water is passed through gratings which retain floating bodies. The settling works very well, thanks to the slowness of the movement of water through the basins and the use of chemical reagents—sulphate of alumina and chalk. About 2,200 lbs. of the first named and 550 lbs. of the second are used to 210,000 cub. ft. of water. The cost is very small, amounting to about 25 cents per inhabitant of the city per year, including in this sum interest on the cost of the works and a sinking fund, as well as the cost of working.

It may be mentioned that in 1885 about 78 per cent. of all the houses in the city were connected with the sewers, and 70 per cent. used the city water. That proportion has been considerably increased since that time.

Results from a hygienic point of view have been very marked. Before 1870 the mortality resulting from typhoid fever showed for several years an average of 71 deaths per year to 100,000 persons. Beginning with 1875, the date at which the new works commenced to produce an effect, this mortality decreased steadily to 16 in 1885, showing a reduction of over 77 per cent., and it is stated now that this terrible disease has now almost entirely disappeared, very few cases having been reported by the health authorities in the last three or four years.

A Submarine Boat.—At the yard of the Detroit Boat Works, Detroit, a few days ago the submarine boat, about which a great deal has been written, was launched. The boat was designed by Fred. A. Ballin, naval architect, and is the property of George A. Baker, of Chicago, who wishes to use her for testing an invention upon which he has been at work for a long time past. The invention consists in reversible propellers, working on each side of the boat amidships. Their duty is to propel as well as regulate the desired immersion. The boat is 40 ft. long, 9 ft. wide and 14 ft. deep, and was built of wood instead of iron or steel for economy's sake. The power is steam, a Roberts safety pipe boiler and Willard engine being used. Compressed air can be stored in the hull.—*Cleveland Marine Review.*

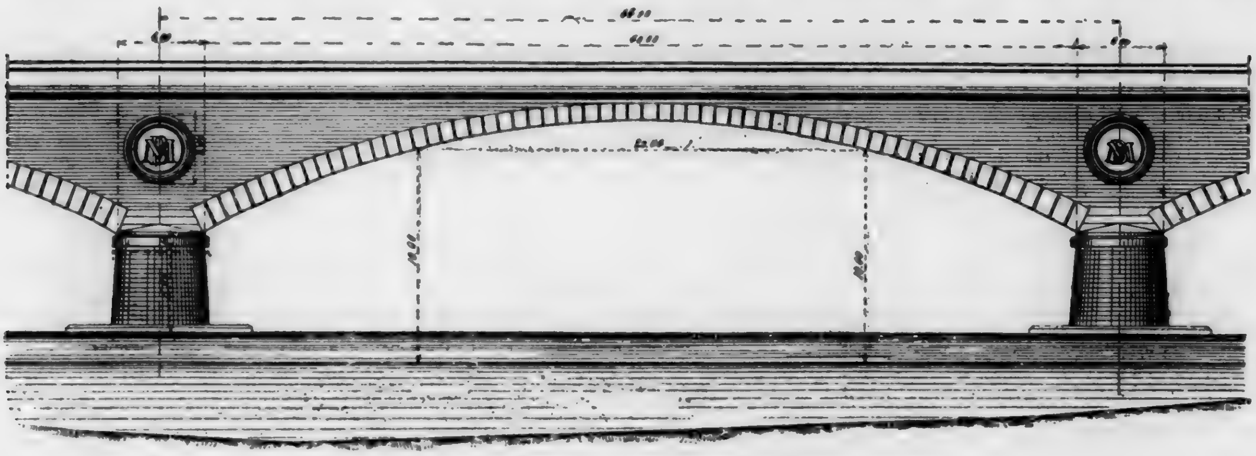
Steam Power of the World.—According to a writer in the *Revue Scientifique*, of Paris, the power furnished by the steam-engines of the whole world represents the labor of 1 000,000,000 men ; that is, of more than twice the number of working-men in existence.

In this calculation the United States stands first, being put down as having steam-engines with a total of 7,500,000 H.P. ; Great Britain has a total of 7,000,000 H.P. ; Germany, 4,500,000 and France, 3,000,000.

These figures do not include the locomotives, the total number of which in the world is estimated at 105,000, representing a total of 5,500,000 to 7,000,000 H.P.

All the steam-engines of the world, including locomotives, would produce a force equivalent to 40,000,000 H.P. if working together.

A French Masonry Bridge.—There has been recently among French engineers a tendency to return to the use of masonry for bridges, especially in localities where suitable stone can be obtained at a reasonable cost. One instance of this is a new



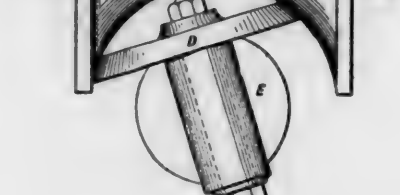
ARCH OF THE BOUCICAUT BRIDGE, VERJUX, FRANCE.

bridge over the Saone at Verjux, which has been named the Boucicaut Bridge, in honor of M. Boucicaut, a wealthy merchant of Paris, who paid for the construction of the bridge as a gift to his native town.

The structure has five arches carried on four piers and two abutments. One of the arches is shown in the accompanying engraving, from *Le Genie Civil.* The arches are all of the same size, having 131.2 ft. span and 16.4 ft. rise. The radius varies from 177 ft. at the summit to 75.5 ft. at the spring. The work is entirely of cut stone, and its cost was about $97,000, not including the approaches.

Novel Friction Gearing.—The device illustrated in the diagram herewith we engrave from a recent patent granted to Mr. C. C. Yates, of Mechanics Falls, Me. It is deserving of attention, and superior to most methods now in use for varying the relative motion of two shafts when a small amount of power is to be transmitted.

On the ends of two shafts, *A* and *B*, are fixed two conical wheels *C* and *C*. Between these is an intermediate wheel bearing on both of the cones. This wheel or disk *D* is mounted on a swiveling plate, *E*, so as to be set at various angles to the axis of the shafts *A* and *B*, bearing at its periphery on the cones



YATES' FRICTION GEARING.

C, at corresponding distances from the center, and varying their relative motion accordingly.

The peculiarity of the gearing, aside from its extreme simplicity, is that the surfaces move together uniformly, and there is not that twisting and grinding action common to other forms of friction gearing when employed for a similar purpose. This method is one especially applicable to the feed motion of machine tools, but would require different proportions from those shown in the diagram. The main disk *C* should be larger in diameter and with less range of variation.—*Industry, San Francisco.*

THE RAILROAD AND
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NEW YORK, FEBRUARY, 1892.

THE table of Locomotive Returns, which is given on another page, is a small beginning, which we hope will be in time increased to include a number of important roads. This can be done by the co-operation of superintendents of motive power, many of whom have already promised it. Comparative statements of this kind cannot fail to bring out some interesting points, and they may perhaps do the further service of impressing upon those in authority how desirable it is to have a uniform system of estimating and stating locomotive performance.

It may be added that we shall be much pleased to receive reports of locomotive service from any superintendent of motive power who may see this notice.

THE Engineering Society of the South has taken up the question of improving highway roads in earnest, and will try several plans to excite increased interest in it. Among others it proposes to have an exhibition of road machinery and tools, and of methods of making and maintaining roads, to be held in Nashville at an early day. It will also have a series of papers on Roads, to be prepared by members and read before the Society at intervals through the year. The object is an excellent one, and there is probably no way in which the Society can do a greater public service. It has certainly set an example worthy to be followed.

THE new railroad building of 1891, according to the statement prepared by the *Railway Age*, amounted to 4,168 miles, being less than in any year of the last ten, except 1884 and 1885, and only about one-third of that of 1887. It was still a fair addition to the railroad mileage of the country, and was distributed in such a way as to indicate that the new lines have generally been placed where they were needed. The building of parallel lines and extensions of competing lines into new territory have, in fact, almost ceased for the time.

As for two years past, the greatest additions have been in the South, but there was still considerable building in the Northwest. The Middle States also show a fair increase, 501 miles being reported in New York, Pennsylvania and New Jersey.

The length of the new lines built averages only about 17 miles, showing that the new mileage was largely of short branches and extensions.

THERE is a rapid transit commission in Boston, and it has recently submitted a preliminary report, proposing a belt or circular line in that city, connecting all the railroad stations and some other points. This line is to be partly an elevated and partly a subway road, and is to form the base from which elevated roads are to radiate out to Cambridge, Dorchester and other suburbs.

THE lake commerce has been so important of late years that it ought not to be a matter of surprise that some of our best ship-yards are now on the inland waters, though many persons do not appreciate the fact. The yards at Cleveland, Detroit, Bay City and other points have grown up to large dimensions within the past few years, and the work they do, both in ships and engines, will stand comparison with any of the yards on the seaboard. In fact, the Bay City yards have already built ships for the Atlantic, and others may follow before long.

THE adaptation of the "whaleback" type of ship to coast defense is proposed by its inventor, Captain McDougall. It includes the monitor principle of an almost entirely submerged hull combined with a strong form of protective deck, and guns could be mounted in a turret. The "whaleback" has, in fact, so many points of similarity to the monitor, that the suggestion of adapting it to war purposes is a natural one.

THE latest report of the Interstate Commerce Commission is an interesting one, and shows that the commissioners have not been idle during the year. The subjects which have been considered are Uniform Classification; Use of Shippers' Cars; Through Routes and Rates; Carriers' Liability, and Risk as Affecting Rates.

The Commission reports a marked improvement during the year in the disposition of carriers to comply with the law in many respects, though little progress has been made in establishing and publishing rates and charges. It is one of the difficulties in the way of the Commission that it can only enforce its orders by bringing suit in the courts, and cannot directly levy penalties or compel obedience.

Several amendments to the law are suggested, the chief of which are to the sections in relation to procedure for violations of the act. It is recommended that power be given to find indictments against the companies directly, instead of their officers. It is also asked that the law be amended so as to fix some time within which a uniform classification of freight must be adopted.

The Statistician's report to the Commission—a very valuable one—is referred to on another page.

THE New York Railroad Commission this year recommends legislation to prevent increase in the number of grade crossings, and to provide for the gradual abolition of those now in existence by separating the grades of railroads and highways wherever practicable. A law to regulate the building of new railroads and to prevent the unnecessary duplication of railroads and building of parallel lines is also recommended.

ENGLISH AND AMERICAN LOCOMOTIVES.

(*Continued from page 6.*)

IV.

IN the preceding articles our argument has been that American locomotives burn more coal, and can therefore do more work in proportion to their size and weight than British engines do, and that by virtue of their greater capacity for doing work, they are more economical, counting all their expenses, than their Anglo-Saxon cotemporaries are. As further evidence that they do more work, we have collected from different locomotive superintendents data concerning the maximum of trains hauled on various roads in this country, which has been tabulated in Table IX.

DATA CONCERNING WEIGHT OF AMERICAN TRAINS.

The Engineer has complained that the parties who have taken part in this discussion on this side the Atlantic have failed to supply full information concerning the performance of American locomotives. In turn, we will complain of the total lack of data concerning the average weight of trains hauled on English roads. In Table III we gave the weight of average passenger and freight trains on a dozen different American lines. Can *The Engineer* give similar data concerning as many British roads? It must be observed that the figures we have given in that table are not haphazard guesses, but are summaries of accounts kept by the different companies for a whole year and published by them.

It is, of course, true that there are many trains on nearly all roads, the weight of which is limited, and there is then no object in pulling more than a given load. In such cases, the end to be aimed at is to haul such trains at as low an expense as possible. Here, too, it is difficult to make any comparisons which will have much value without knowing the weight and speed of such trains, the stops they must make, and the grades over which they must be hauled. The best data, probably, which is obtainable concerning the performance of American locomotives on trains of that kind, is contained in what are called the "coal allowance sheets," which are employed on the Pennsylvania Railroad lines.

A little explanation of the system in vogue on these roads may be needed to explain the significance of those allowance sheets. On the Philadelphia, Wilmington & Baltimore, and on the Pittsburgh, Fort Wayne & Chicago roads, for example, a certain allowance of coal—depending upon the character of the train, the nature of its run, schedule time, number of stops, etc.—is made for the engine and another allowance for each car per mile run. One half of the value of the saving of this allowance, which the engineer and fireman can make, is divided between them as a bonus. The allowances are revised each month, and are kept within such limits, so that skillful and careful men can make a bonus, while those who are indifferent, indolent or ignorant cannot. Through the favor of some of the officers on the lines referred to, we have received copies of the coal allowance sheets on those roads for the month of January of this year, from which Table X has been collated.

The coal allowed per train mile for the different classes of trains has been calculated and is given in the eleventh column, from which it will be seen that on the Philadelphia, Wilmington & Baltimore road the average for passenger trains is 55.61 lbs. and for freight 75.26 lbs. On the Pittsburgh, Fort Wayne & Chicago the corresponding figures are 49.8 and 130.9 lbs.

The coal allowed per ton per mile of the weight of the cars has also been computed, and the results are given in column 12. The average for passenger cars on the Philadelphia, Wilmington & Baltimore road is .694 lb. and for freight .253 lb. per ton per mile. On the Pittsburgh, Fort Wayne & Chicago it is 0.33 and 0.22 lb. The average consumption has also been calculated in a similar way for through and local or accommodation passenger trains, and for through and local freight trains.

It must be kept in mind that the figures in this table represent the ordinary every-day practice on the lines named, and are not reports of special experiments or tests, which always give better results than daily usage does. The coal allowance is also somewhat greater than the actual consumption, because many of the men run with less coal than the allowance, and thus, as has been explained, make a bonus on their month's work. The character of the trains hauled on the Philadelphia, Wilmington & Baltimore road is probably as near to that of average English trains as can be found in this country.

We are unable to compare these figures with English practice, because we have no similar reports of what is done on British roads. Can *The Engineer* give its readers some such data? The missing link in all reports of locomotive performance in the United Kingdom is the weight of their trains. The only way of getting such information seems to be by some process of inference, such as was employed in our article published in December. It will be remembered that from the "guess" of Mr. Ackworth, with reference to freight rates on British roads, the statistics of traffic receipts of goods trains per mile, and the hypothesis that the dead weight of "wagons" was twice the paying load hauled, the inference was that the average weight of English goods trains is 170 tons, not including the engine and tender. On the Philadelphia, Wilmington & Baltimore road the average of the weights given is nearly twice and on the Fort Wayne road it is more than three times as great. If we compare the daily performance on the Philadelphia, Wilmington & Baltimore road with the North British experiments, we find that on the former the average weight of trains was 336.8 tons, on the latter 243.4 tons; the consumption of coal per train mile was 75.26 lbs. in the first case and 64.56 in the second; the consumption of coal per ton of train per mile was .272 lbs. on the Scotch road and .253 on the Philadelphia, Wilmington & Baltimore. It may be repeated that in the one instance the figures represent the results of careful experiment, and in the other every-day practice.

Since the publication of these articles was commenced, reports have been published of some remarkable tests of fast express locomotives, of which we give the data in table XI. The first of these is from a brief report of the performance of a locomotive with a single pair of driving-wheels 7 ft. 7½ in. diameter, and with inside cylinders —which is the type of engine used on the Great Northern Railway of England. This report was published in *The Engineer* of November 6. In its issue of November 20 our cotemporary gave a report of a very remarkable performance of Mr. Webb's new compound engine "Greater Britain," which was illustrated in the last number of the JOURNAL. A summary of this report is also given in our table. The third line contains the data of the per-

TABLE IX.—SHOWING THE MAXIMUM LOADS HAULED, WITH THE WEIGHT AND PERFORMANCE OF LOCOMOTIVES, ON DIFFERENT AMERICAN RAILROADS.

1 Name of Road.	2 Terminal Points.	3 Distance between Terminals.	4 Number of Loaded Freight Cars Hauled.	5 Number of Empty Freight Cars Hauled.	6 Number of Mart, Baggage, Express or Postal Cars Hauled.	7 Number of Coaches Hauled.	8 Number of Drawing-Room, Sleeping or Dining Cars Hauled.	9 Total Number of Cars Hauled.	10 Weight of Cars in Tons of 2,240 Lbs.	11 Maximum Grades on Run.	12 Schedule Time, including Stops.		13 Kind of Engine Employed.	14 Total Weight of Engine in Working Order.	15 Total Weight on Driving-Wheels.	16 Diameter of Driving-Wheels.	17 Size of Cylinders.	18 Coal Consumed per Mile.	19 Coal Consumed per Ton of Train Exclusive of Engine and Tender.	20 Proportion of Weight of Engine to Weight of Cars Hauled.	21 Miles per Hour.
PASSENGER TRAINS.																					
		Miles.							Tons of 2240 lbs	Ft. per m.	H.	M.		Lbs.	Lbs.	In.	In.	Lbs.	Lbs.		
Boston and Albany	Boston and Springfield	100	....	....	1	3	3	7	206	60	2	29	Am.	90,000	61,400	68	18 × 22	......	......	1 to 5.13	40.26
New York, New Haven and Hartford	Springfield and New York	137	....	....	1	5	2	8	219	45	3	29	"	100,000	62,700	68½	18½ × 24	......	......	1 " 4 9	39.30
" " " "	" " "	137	....	....	2	3	6	11	340	45	4	15	"	100,000	62,700	68½	18½ × 24	......	......	1 " 7.62	32.22
Fitchburg	......	143	....	....	3	4	3	10	284	60	5	..	"	94,660	60,660	68	18 × 24	......	......	1 " 6.73	28.56
Old Colony	Fall River and Boston	49	....	....	2	7	2	11	367.2	45½	1	20	"	98,000	63,210	69	18 × 24	63	.171	1 " 8.59	36.75
Missouri Pacific	St. Louis and Sedalia	189	....	....	2	5	5	12	352.7	52	6	55	10-wheel.	114,000	90,000	63	20 × 24	80	.227	1 " 6.03	27.30
Chicago, Burlington and Quincy	Galesburg and Chicago	162.5	....	....	2	3	3	8	261.1	37	4	2	Mogul.	110,000	91,500	68	19 × 24	56 2	.215	1 " 5.31	40.26
" " " "	Creston and Council Bluffs	105	....	....	3	3	4	10	294.6	69	3	10	"	110,000	91,500	62	19 × 24	76	.257	1 " 5.00	33.18
Delaware, Lackawanna and Western	Buffalo and Hoboken	409	....	....	4	3	3	10	348.7	75†	11	58	Am.	111,500	80,800	68	19 × 24	......	......	1 " 6.98	34.14
Baltimore and Ohio	Keyser, Md., and Grafton, W. Va.	78.7	....	....	3	2	1	6	187.3	116 (c)	3	45	10-wheel.	133,000	103,300	62	21 × 26	87	.464	1 " 3.15	20.94
Western New York and Pennsylvania	Oil City and Buffalo	137	....	....	2	7	1	10	247	90	5	..	Am.	87,000	58,000	62	17 × 24	80	.324	1 " 6.35	27.36
New York Central and Hudson River	New York and Albany	143	....	....	1	2	9	12	392	......	3	50	"	98,000	64,000	70	18 × 24	......	......	1 " 8.96	37.26
" " " "	......	143	....	....	....	....	8	8	298.5	......	3	25	"	120,000	80,000	70	19 × 24	......	......	1 " 5.57	41.82
Chicago and Northwestern	Chicago and Janesville	91	....	....	3	3	5	11	331	32	...	...	10-wheel.	......	94,500	64	18 × 24	......	......	......	33.00
" " "	" " Clinton	138	....	....	2	3	5	10	343	39.6	...	...	Am.	......	61,870	64	18 × 24	......	......	......	33.10
" " "	" " Turner	30	....	....	8	6	1	15	377	26.4	...	...	"	......	51,650	64	18 × 24	......	......	......	34.80
St. Louis and San Francisco	St. Louis and Newburg	119	....	....	3	4	2	9	288	70	4	30	10-wheel.	100,000	65,000	58	19 × 24	83⅓	.289	1 " 6.45	26.40
Chicago and Alton	Bloomington and Chicago	126⅓	....	....	3	4	4	11	402	52	4	55	Am.	85,000	56,000	63	17 × 24	67	.166	1 " 10.50	25.68
Canadian Pacific	Montreal and Toronto	344	....	....	2	3	5	10	335	52.8	10	55	10-wheel.	117,000	93,000	69	19 × 24	66	.197	1 " 6.41	30.66
Louisville and Nashville	Howell and Nashville	154	....	....	2	2	3	7	208	81‡‡	5	40	Am.	96,000	62,000	67	18 × 24	......	......	1 " 4.85	27.18
New York, Lake Erie and Western	Hornellsville and Susquehanna	139¾	....	....	2	3	3	8	272	....	4	10	"	......	80,400	68	19 × 24	......	......	......	33.54
" " " "	" " "	139¾	....	....	....	....	....	....	280.3	......	4	10	10-wheel.	118,700	101,000	68	20 × 24	76.8 (a)	.274	1 " 5.28	33.54
New York, Providence and Boston	Providence and New London	64	....	....	2	3	4	8	270.5	......	1	45	Am.	96,000	65,000	69	17 × 24	54	.299	1 " 6.31	36.54
Michigan Central	Jackson and Michigan City	153	....	....	2	3	6	11	379	45	5	50	10-wheel.	123 500	96,000	68	19 × 24	......	......	1 " 6.87	26.22
" "	Michigan City and Jackson	153	....	....	....	1	6	7	294.2	38	3	30	"	123,500	96,000	68	19 × 24	......	......	1 " 5.33	43.68
Atchison, Topeka and Santa Fé	Topeka and Nickerson	179	....	....	3	6	2	11	334.8	63	8	10	10-w. comp.	135,000	99,200	62	20 × 24, 29 × 24	72	.215	1 " 5.55	21.90
" " " "	La Junta and Denver	181	....	....	8	3	1	12	354.4	74	8	40	10-wheel.	121,000	87,000	56	18 × 24	88	.248	1 " 6.56	20.88
Wisconsin Central	Chicago and Waukesha	97.7	....	....	1	1	9	11	361.5	52.8	3	20	Am.	92,600	60,000	63	17 × 24	53	.146	1 " 8.74	29.28
Lake Shore and Michigan Southern	Buffalo and Erie	88	....	....	2	3	6	11	358	35	2	20	"	108,000	72,000	66	18 × 24	69.42	.194	1 " 7.48	37.68
Cleveland, Cinn., Chicago and St. Louis	Cincinnati and Chicago	110	....	....	3	2	5	10	357	42 (b)	3	15	10-wheel.	126,700	98,[illegible]00	62	19 × 24	95.8	.268	1 " 6.31	33.84
Missouri, Kansas and Texas	Denison and Muscogee	158	....	....	3	3	3	9	290	53	....	....	Am.	82,000	52,000	62	17 × 24	50.08	.183	1 " 7.92	28.00
Baltimore and Ohio	Canton and Philadelphia	91.6	....	....	1	2	1	4	137 6	76	1	47	"	114,500	77,000	78	20 × 24	53	.385	1 " 2.71	51.30
Philadelphia and Reading	Philadelphia and Pottsville	93	....	....	2	4	2	8	225	28.5	2	52	" (e)	107,000	72.464	68½	21 × 22	67.18 (f)	.298	1 " 4 71	50.00
FREIGHT TRAINS.																					
Missouri Pacific	St. Louis and Chamois	100	45	......	....	....	....	....	1,125	52 & 36*	......		Consol.	114,000	103,000	50	20 × 24	117	.104	1 " 22.10	...
Delaware, Lackawanna and Western	Hoboken and Binghamton	207	28	......	....	....	....	....	1,125	......	11	33	Mogul.	98,000	85,220	62	19 × 24	......	......	1 " 25.71	17.88
Baltimore and Ohio§	Piedmont and Altamont	17	12	1 Caboose	....	....	....	....	333	116‡	2	4¼	Consol.	125,000	113,400	50	21 × 26	411	1.234	1 " 5.97	8.16
" " "§	" " "	17	14	1 "	....	....	....	....	452	116‡	1	54	"	155,150	137.600	50	22 × 28	382	.845	1 " 6.52	8.94
Western New York and Pennsylvania	Buffalo and Emporium	121	50	......	....	....	....	....	1,393	26	11	..	"	127,000	113,000	50¼	20 × 24	105	.075	1 " 24.57	11.00
New York Central and Hudson River	" " New York	440	56**	......	....	....	....	....	1,800	30	15	8	Mogul.	120,000	105,000	64	19 × 26	......	......	1 " 33.60	29.04
Chicago and Northwestern	Chicago and Clinton	135	40	......	....	....	....	....	718	36.9	......		10-wheel.	... ...	79,700	56¼	19 × 24	... ...	......	......	15.00
St. Louis and San Francisco	Choteau Ave. and Newburg	117	34	......	....	....	....	....	602	70	7	††	Consol.	117,000	101,600	51	20 × 24	100.	.166	1 " 11.52	16.68
Chicago and Alton	Bloomington and Brighton Park	121.5	35½	......	....	....	....	....	739	52	9	30	Am.	85,000	56,000	63	17 × 24	128¼	.173	1 " 19.53	12.78
Canadian Pacific	Montreal and Toronto	334.6	23	......	....	....	....	....	636	52.8	24	10	10-wheel.	108,000	88.000	62	18 × 24	90	.141	1 " 13.19	13.80
Chicago, Burlington and Quincy	Galesburg and Chicago	162.5	37	......	....	....	....	....	826	37	8	..	Mogul (d).	114,500	96,150	62	20 and 29 × 24	86.6	.105	1 " 16.15	20.28
" " " "	" " "	162.5	39	......	....	....	....	....	870	37	8	..	"	110,000	94,500	68	19 × 24	98.4	.113	1 " 17.71	20.28
" " " "	Creston and Council Bluffs	105	47½	......	....	....	....	....	781	69	......		Consol.	113,000	95,100	52	20 × 24	100	.128	1 " 15.48	.....
Louisville and Nashville	Howell and Nashville	154	40	......	....	....	....	....	500	81‡‡	11	50	Consol.	118,600	....	51	20 × 24	96.22	.192	......	13.02
New York, Lake Erie and Western	Susquehanna and Hornellsville	139¾	65½	......	....	....	....	....	1,677	......	7	23	10-wheel.	138,100	111,750	62	21 × 26	158.1	.094	1 " 27.20	18.90
Michigan Central	Jackson and Michigan City	153	36	1 Caboose	....	....	....	....	1,000	45	......		Mogul.	102,000	88,000	57	19 × 24	......	......	1 " 21.96	.....
Atchison, Topeka and Santa Fé	La Junta and Denver	181	38	16	....	....	....	....	1,000	74	13	35	10-wheel.	106,400	78,200	51	19 × 26	122	.122	1 " 21.05	13.32
Wisconsin Central	Waukesha and Stevens Point	151.4	34	......	....	....	....	....	803	52.8	11		Mogul.	107,050	89,900	57	19 × 26	61	.076	1 " 16.77	13.74
Lake Shore and Michigan Southern	Buffalo and Erie	88	50	......	....	....	....	....	1,473	35	6	25	"	118,000	100,000	54	19 × 24	89.64	.061	1 " 27.96	13.74
Cleveland, Chicago, Cinn. and St. Louis	Cincinnati and Chicago	110	35	......	....	....	....	....	1,060	42 (b)	..	......	10-wheel.	90,000	.. ...	55	18 × 24	74	.070	1 " 26.38	....
Missouri, Kansas and Texas	Denison and Muscogee	158	27	......	....	....	....	....	755	53	......		Mogul.	100,000	86.000	53	19 × 24	103.55	.137	1 " 16.91	15.00
Old Colony	Mansfield and South Framingham	21	32½	......	....	....	....	....	715	50	1	20	"	108,500	93,000	54	19 × 24	87	.122	1 " 14.76	15.70
Philadelphia and Reading	Schuylkill Haven and Belmont	85.6	100	......	....	....	....	....	1,547	......	9	43	10-wheel (e).	121,000	94,000	60⅝	20 × 24	151.7	.098	1 " 28.64	....
" " "	Palo Alto and Reading	36.5	55	......	....	....	....	....	1,899	......	......		Consol (e).	116,800	101,470	50½	20 × 24	......	......	1 " 36.42	....
" " "	Reading and Philadelphia	58	50	......	....	....	....	....	1,719	... .	......		"	116,800	101,470	50½	20 × 24	......	......	1 " 32.96	....
" " "	Schuylkill Haven and Phila. (g)	89	90	......	....	....	....	....	3,102	......	...	...	"	153,000	138.530	50½	22 × 28	......	......	1 " 45.42	...

* Pushing engine is used on the 52-ft. grade, but not on 36 † Engine has helper on this grade. ‡ 10° curves on grade; no reduction of grade on curves. § Experimental trips; no helping engine was used. ** These cars weigh 28,000 lbs., and their average load is 44,000=total, 72,000 lbs. †† Grade 26,300 ft. ‡‡ The maximum grade on this run is 217 ft. per mile for 1.8 miles and curves of 573.7 ft. radius, but the trains are divided here, and helping engines are used. (a) Poor quality of anthracite coal. (b) One grade of 70 ft., on which helper is used. (c) This grade is 17 miles long. (d) Compound. (e) Wootton engine. (f) Anthracite. (g) Experimental train.

TABLE X. SHOWING THE ALLOWANCES OF COAL PER ENGINE AND PER CAR MILE ON THE PHILADELPHIA, WILMINGTON AND BALTIMORE, AND THE PITTSBURGH, FORT WAYNE AND CHICAGO RAILROADS.

PHILADELPHIA, WILMINGTON AND BALTIMORE RAILROAD.

TERMINAL POINTS.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
	Miles.	No.	Ft. per Mile.	Minutes.	Miles per Hour.	No.	Tons of 2,240 lbs.	Lbs.	Lbs.	Lbs.	Lbs.
LOCAL PASSENGER TRAINS.											
Philadelphia and Baltimore	95.8	29.5	37.	179.2	31.9	3.76	93.3	18.	8.0	48.08	.723
" " Newark	26.2	16.8	30.	61.9	25.4	3.85	95.5	22.	10.0	57.36	.808
" " Lamokin	19.4	12.7	30.	45.1	25.8	4.18	103.5	22.	10.2	60.50	.584
Baltimore " Washington	42.6	14.0	53.	84.0	30.4	3.67	91.1	20.	8.8	52.29	.574
" " Catonsville	13.2	15.5	132.	32.2	25.0	2.46	62.0	25.	15.0	51.90	.837
Washington " Quantico	34.5	10.0	53.	82.5	25.2	4.79	118.1	20.	8.2	59.27	.502
" " Alexandria	6.7	5.0	53.	[illegible]	20.1	3.40	84.6	25.	10.2	59.68	.705
Averages							92.6			55.58	.676
NEWSPAPER TRAIN.											
Washington and Baltimore	42.2	13.0	53.	75.0	33.7	1.84	46.6	25.	13.5	49.84	1.078
THROUGH PASSENGER TRAIN.											
Philadelphia and Washington	137.6	11.5	53.	223.9	36.9	5.70	140.1			61.56	.439
Average of all passenger trains										55.61	.694
THROUGH FREIGHT TRAINS.											
Philadelphia and Baltimore	95.8		37.			20.25	506.2	14.	3.0	74.75	.147
Baltimore " Washington	42.6		53.			15.09	377.2	16.	3.8	73.34	.194
Quantico " "	34.5		53.			15.15	378.7	16.	4.0	76.60	[illegible]
Averages							420.7			74.89	.181
FAST FREIGHT TRAIN.											
Philadelphia and Wilmington	26.8		30.			18.17	454.2	16.	3.8	95.04	.209
LOCAL FREIGHT TRAINS.											
Philadelphia and Wilmington	26.8		30.			6.82	170.5	18.	6.4	61.64	.361
Wilmington " Perryville	32.9		37.			8.38	209.5	18.	7.8	83.36	.400
Baltimore " "	36.1		21.			8.46	211.5	18.	6.4	72.14	.341
Philadelphia " "	59.7		37.			16.06	401.5	16.	3.6	73.81	.183
Quantico " Washington	34.5		53.			11.49	287.2	18.	4.8	55.15	.193
Baltimore " "	42.6		53.			6.39	160.2	16.	7.8	65.84	.411
Averages							220.1			68.66	.315
COLUMBIA FREIGHT TRAIN.											
Wilmington and Perryville	32.9		37.			20.29	507.2	16.	3.6	89.04	.175
DISC. FREIGHT TRAIN.											
Quantico and Washington	34.5		53.			15.10	377.5	16.	4.4	82.44	.218
Average of all freight trains							336.8			75.26	.253

PITTSBURGH, FORT WAYNE AND CHICAGO LINE.

TERMINAL POINTS.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
THROUGH PASSENGER TRAINS.											
EASTERN DIVISION.											
Pittsburgh and Crestline	188.8	19	59.14	430	26.33	8	218.8	30.0	5.0	70.0	0.32
" " "	188.8	7	58.61	345	32.83	5	134.9	30.0	8.0	70.0	0.52
" " "	188.8	26	59.14	465	24.36	8	218.8	30.0	5.5	74.0	0.34
" " "	188.8	32	58.61	520	21.98	7	183.0	30.0	4.5	61.5	0.34
" " "	188.8	11	58.61	405	27.97	9	254.5	30.0	5.5	79.5	0.32
" " "	188.8	10	59.14	385	29.42	10	281.3	30.0	6.0	90.0	0.32
" " "	188.8	39	58.61	450	25.17	5	134.9	30.0	6.5	62.5	0.46
" " "	188.8	[illegible]	58.61	445	25.46	7	183.0	30.0	5.5	68.5	0.37
" " "	188.8	5	59.14	310	32.36	6	159.0	30.0	6.0	66.0	0.42
" and Alliance	83.2	5	58.61	165	30.25	10	281.3	30.0	4.5	75.0	0.27
" " "	83.2	30	59.14	215	43.22	5	134.9	30.0	7.0	65.0	0.48
Average							198.6			71.1	0.36
WESTERN DIVISION, SUBDIVISION C.											
Crestline and Fort Wayne	131.2	25	33.79	280	28.11	7	183.0	25.0	5.0	60.0	0.33
" " " "	131.2	8	31.68	190	41.43	5	134.9	25.0	8.0	65.0	0.48
" " " "	131.2	16	33.79	280	28.11	8	218.8	25.0	2.8	47.4	0.22
" " " "	131.2	18	31.68	285	27.62	10	281.3	25.0	5.0	75.0	0.27
" " " "	131.2	18	31.68	285	27.62	5	134.9	25.0	1.5	32.5	0.24
" " " "	131.2	9	33.79	185	42.55	5	134.9	25.0	7.0	60.0	0.44
" " " "	131.2	8	33.79	193	40.79	5	134.9	25.0	5.0	50.0	0.37
" " " "	131.2	13	31.68	230	39.36	9	254.5	25.0	5.5	74.5	0.29
Average							184.7			58.1	0.32
WESTERN DIVISION, SUBDIVISION D.											
Fort Wayne and Chicago	148.3	31	35.33	305	29.17	7	183.0	25.0	3.5	49.5	0.27
" " "	148.3	19	35.33	315	28.25	8	218.8	25.0	4.3	59.4	0.27
" " "	148.3	23	33.79	330	26.96	9	254.5	25.0	2.5	47.5	0.19
" " "	148.3	12	35.33	240	37.08	6	159.0	25.0	7.2	68.2	0.43
" " "	148.3	12	35.33	260	34.22	5	134.9	25.0	4.5	47.5	0.35
" " "	148.3	17	33.79	270	32.96	10	281.3	25.0	4.5	70.0	0.25
" " "	148.3	15	35.33	265	33.58	7	183.0	25.0	5.4	62.8	0.34
" " "	148.3	30	33.79	305	29.17	7	183.0	25.0	5.0	60.0	0.33
" " "	148.3	13	33.79	240	37.08	6	159.0	25.0	7.0	67.0	0.42
Average							195.2			59.1	0.30

Terminal Points.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
	Miles.	No.	Ft. per mile.	Minutes.	Miles per hour.	No.	Tons of 2,240 lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Cleveland and Pittsburgh Division.											
Cleveland and Pittsburgh	149.3	45	52.80	380	23.57	6	159.0	20.0	7.2	63.2	0.40
" " Ravenna and Return	76.0	30	40.00	115	19.83	4	110.7	20.0	10.0	60.0	0.54
" " Alliance " "	113.0	18	40.00	145	23.39	3	86.6	20.0	9.0	47.0	0.54
" " Hudson " "	52.4	8	40.00	65	24.00	4	110.7	20.0	9.5	58.0	0.52
" " Pittsburgh	149.3	43	52.80	390	22.97	5	134.9	20.0	7.3	56.5	0.42
Average	......	......	......	......	......	......	120.4	......	......	56.9	0.47
Toledo Division.											
Mansfield and Toledo	85.6	32	48.00	180	28.53	5	134.9	20.0	7.5	57.5	0.43
" " "	85.6	30	48.00	180	28.53	3	86.6	20.0	5.2	35.6	0.41
" " "	85.6	32	48.00	195	26.34	3	86.6	20.0	5.5	36.5	0.42
" " "	85.6	32	48.00	190	27.03	3	86.6	20.0	6.8	40.4	0.47
" " "	85.6	32	48.00	190	27.03	4	110.7	20.0	5.5	42.0	0.38
Average	......	......	......	......	......	......	101.1	......	......	42.4	0.42
ACCOMMODATION TRAINS.											
Eastern Division.											
Trains 41, 42, 43, 44	44.2	40	59.14	120	22.10	5	123.2	30.0	11.0	85.0	0.69
" 111, 112, 113, 118	13.7	19	43.30	45	18.27	4	99.1	30.0	11.0	74.0	0.75
" 54, 55	29.9	23	52.80	75	23.92	5	123.2	30.0	11.0	85.0	0.69
" 52, 51, 56, 57	29.9	23	52.80	75	23.92	5	123.2	30.0	9.0	75.0	0.61
" 107, 109, 114, 115, 116, 122, 123, 132	13.7	21	43.30	45	18.27	4	99.1	30.0	8.5	64.0	0.65
Average	......	......	......	......	......	......	113.6	......	......	76.6	[illegible]
Western Division.											
Local train 35	131.2	25	33.79	270	29.16	3	75.0	25.0	1.5	29.5	0.39
" " 36	131.2	25	31.68	320	24.60	3	75.0	25.0	2.0	31.0	0.41
" " 38	148.3	33	33.79	310	28.70	3	75.0	25.0	5.0	40.0	0.53
" " 40	148.3	21	33.79	325	27.38	5	123.2	25.0	1.5	32.5	0.26
" " 47, 48	64.1	15	35.33	75	28.44	3	75.0	25.0	3.0	34.0	0.45
Chicago local trains, daily average	85.6	23	....	285	18.55	3	75.0	25.0	17.0	76.0	1.01
Average	......	......	......	......	......	......	83.0	......	......	40.5	0.49
Cleveland and Pittsburgh Division.											
River Division Accommodations 39, 40	189.2	94	31.68	255	22.26	3	75.0	20.0	10.0	50.0	0.67
" " " 58, 59, 338	139.2	113	31.68	130	31.42	3	75.0	20.0	13.0	59.0	0.79
Average	......	......	......	......	......	......	75.0	......	......	54.5	0.73
Average of all passenger trains	......	......	......	......	......	......	151.8	......	......	49.8	0.33
THROUGH FREIGHTS.											
Eastern Division.											
Allegheny and Crestline	186.8	6	59.14	740	15.14	24	600.0	30.0	3.0	108.0	0.17
Conway and Crestline	166.1	6	59.14	660	15.10	24	600.0	30.0	3.5	114.0	0.19
Allegheny and Alliance	82.2	0	59.14	320	15.41	24	600.0	30.0	4.0	126.0	0.21
Allegheny and Conway	20.7	0	26.40	80	15.43	35	875.0	30.0	3.0	135.0	0.15
Alliance and Crestline	105.2	5	51.22	405	....	24	600.0	30.0	3.2	106.8	0.18
Average	......	......	......	......	......	......	655.0	......	......	116.8	0.18
Western Division.											
Crestline and Fort Wayne	131.2	10	33.79	727	10.83	40	1000.0	30.0	2.0	110.0	0.11
Cleveland and Pittsburgh Division.											
River Division trains 72, 73, 74, 75	185.6	50	31.68	955	11.66	40	1000.0	25.0	3.5	165.0	0.17
" " " 78, 79	43.8	32	31.68	645	4.07	40	1000.0	25.0	6.0	265.0	0.27
Average	......	......	......	......	......	......	1000.0	......	......	215.0	0.21
LOCAL FREIGHTS.											
Eastern Division.											
Allegheny and Alliance	81.2	....	59.14	320	15.23	18	450.0	30.0	7.0	156.0	0.35
" " "	81.2	....	59.14	320	15.23	10	250.0	30.0	6.0	90.0	0.36
Alliance and Crestline	106.0	....	51.22	405	15.70	10	250.0	30.0	5.0	80.0	0.32
Average	......	......	......	......	......	......	316.7	......	......	108.7	0.34
Western Division.											
Subdivision C, local train 86	71.8	16	28.51	565	7.62	25	625.0	....	7.0	....	....
" " " " 87	71.8	17	33.79	500	8.62	25	625.0	....	3.0	....	....
" " " " 89	59.4	13	28.30	515	6.92	25	625.0	....	5.5	....	....
Subdivision D, local trains 90, 91	64.1	17	35.33	490	7.85	25	625.0	....	4.0	....	....
" " milk train	43.9	9	27.98	130	20.23	2	50.0	25.0	10.5	46.0	0.92
Average	......	......	......	......	......	......	510.0	......	......	....	....
Cleveland and Pittsburgh Division.											
Local freight	99.0	29	...	600	9.90	8	[illegible]	25.0	6.0	73.0	0.37
Hill train	73.1	12	52.80	660	6.65	19	475.0	25.0	12.0	253.0	0.48
River Division local freight	72.0	34	31.68	600	7.20	20	500.0	25.0	6.0	145.0	0.29
Average	......	......	......	......	......	......	391.7	......	......	157.0	0.40
Toledo Division.											
Toledo and Mansfield, local	85.6	32	43.00	565	9.09	25	625.0	20.0	4.6	135.0	0.22
" " " "	85.6	32	43.00	620	8.28	21	525.0	20.0	5.8	141.8	0.27
" " " through	85.6	12	43.00	405	12.68	25	625.0	20.0	2.8	90.0	0.14
" " " "	85.6	12	43.00	455	11.29	21	525.0	20.0	4.3	110.3	0.21
" " " extra	85.6	12	43.00	360	14.27	25	625.0	20.0	2.8	90.0	0.14
Average	......	......	......	......	......	......	585.0	......	......	113.4	0.19
Average of all freight trains	......	......	......	......	......	......	596.1	......	......	130.9	[illegible]

Table XI. Showing the Performance of Fast Express Locomotives on Different Roads.

Road.	1 Designer of Engine.	2 Date of Test.	3 Weight of Engine.	4 Weight of Train Exclusive of Engine and Tender.	5 Proportion of Weight of Engine alone to Train of Cars alone.	6 Distance Run.	7 Speed in Miles per Hour.	8 Coal Consumption per Train Mile.	9 Coal Consumption per Ton of Train—not including Engine and Tender—per Train Mile.
			Tons of 2,240 lbs.	Tons of 2,240 lbs.		Miles.		Lbs.	Lbs.
1 Great Northern Railway	Patrick Stirling.	....	40.13	177.6	1 to 4.42	....	50+	30.6	.170
2 London & Northwestern..................	F. W. Webb....	Nov. 4, 1891	52.	305.5	1 " 5.76	158.	42.8	41.1	.134
3 Chemin de Fer du Nord.	M. du Bousquet.	Oct. 16, 1891	43.	139.	1 " 3.23	184.6	53.3	....	....
4 New York Central & Hudson River.....	Wm. Buchanan.	Apr. 5, 1890	42.2	341.	1 " 8.08	143.	45.64	60.95	.178
5 " " " " "	"	Apr. 29, 1890	42.2	261.5	1 " 6.19	143.	42.9	45.03	.172
6 " " " " "	"	Apr. 29, 1890	42.2	261.5	1 " 6.19	143.	41.85	46.0	.176
7 " " " " "	"	May 10, 1890	42.2	261.5	1 " 6.19	143.	41.85	30.63	.117

formance of a French engine, and in the fourth to the seventh the figures are given of the working of an engine on the Hudson River road.

The report of the working of Mr. Webb's new engine is certainly very remarkable. The amount of water evaporated per pound of coal is said to have been 10.96 lbs. We have no reason for doubting the correctness of the report, of which Mr. Webb's reputation is sufficient guarantee. If the remarkable results obtained in this experimental trip are realized in practice, the plan of boiler which Mr. Webb has introduced will probably be generally adopted. Before doing so, it would be well, however, to have fuller information about the manner in which the remarkable results were obtained, and wait for the reports of every-day working.

In speaking of the performance of the North British engine, *The Engineer* says, "It consumed 30.6 lbs. of *best South Yorkshire coal* per mile run." Now, what is meant by the *best* coal? Perhaps the following extract from a letter received from an Englishman, now employed on one of our leading American roads, may throw some light on the question. He says:

"As regards the quality of coal they use in England, I can say, from my own knowledge, it is the best that can be obtained. In the locality where I was stationed we had principally Ebbwvale and Tredegar coal, the best Welsh coal in the market; and it was stated in the contract it was to be *hand picked;* that was understood to be clean coal, *all lumps*, no dirt whatever. This, I assure you, is very different from the quality we use in America."

Now in comparing the performance of one engine with another, it is of importance to know what kind of coal was used. We admit that even with the best coal the results of the experiments with Mr. Webb's engine are very remarkable; but in order to make a comparison of the ordinary performance of an American engine with that of the foreign engines reported in our table, we have selected several runs on the Hudson River road which were made under Mr. Buchanan's supervision in the ordinary traffic of the road. The coal used was not of the best quality, and was used because it was cheap. The Hudson River road, it should be added, is nearly level, and probably not so hard a line to work as the three foreign lines are, but we have no record of their grades and curves.

From the table it will be seen that the Great Northern engine pulled 4.42 times its own weight, the French engine 3.23 times, Mr. Webb's 5.76 times, and in one run the Hudson River engine's train was 8.08 times as heavy as itself. With this heavy train the coal consumption was .178 lb. per ton per mile, whereas Mr. Webb's burned only .134 lb.; but with a train 6.19 times as heavy as itself, Mr. Buchanan's engine burned only .117 lb. of coal per ton per mile.

Now it is freely admitted that this comparison is not conclusive evidence of the merits of the engines, because the alignment of the roads, the quality of the fuel and other conditions were not the same; but the data are given to indicate that it is by no means a foregone conclusion, as *The Engineer* seems to assume, that under like conditions American express engines are not equally economical in fuel consumption as their foreign cotemporaries are. It is obviously unfair to compare an English compound with American simple locomotives; but the reports of the working of compound locomotives in this country have not yet emerged from that turbid condition which all subjects seem to get into when they are first stirred up. *The Engineer*, we trust, will give its readers the latest and fullest information regarding the working of compound locomotives in its own country, and the Railroad and Engineering Journal will perform a similar service for its readers by reporting what is done here by the same class of engines. If our knowledge is thus increased, this discussion will not have been futile. Up to the present point it may, we think, be fairly summarized by saying that it has been shown:

1. That the average annual mileage of locomotives on the railroads of the United Kingdom is 24,610; in this country it is 35,650.

2. The average weight of passenger trains, not including engines and tenders, as shown by the reports of 12 leading roads in this country, is 130.3 tons; that of freight trains is 601.5 tons. The average weight of trains in Eng-

land, Scotland and Ireland is not known. There is good reason for thinking, though, that the weight of our trains is much greater than the average on British lines. If this is true, it will follow that American locomotives not only run further, but they haul heavier loads than English engines do.

3. The average cost of repairs of the latter is 5.30 cents per mile run, while that of American locomotives is only 4.25 cents. Therefore they run further, pull more, and cost less than their congeners on the "tight little island."

4. The maximum rate of combustion per square foot of grate per hour, in our locomotives, is considerably over 100 lbs., and it has been shown that it is at times as much as 193.7 lbs., and is reported as being over 200 lbs. *The Engineer* has admitted that "*we have nothing in England to equal this. About 75 lbs. per square foot of grate per hour may be regarded as a maximum consumption with our fastest and heaviest expresses.*" Now either *The Engineer* is mistaken in this admission, or else the greater capacity which American locomotives have of burning coal enables them to generate more steam and thus pull heavier loads. It is believed that *The Engineer* was wrong when it made the above admission, but we also believe that if it should change the above estimate so as to correspond with actual practice in its own country, it will still be found that our locomotives have a greater capacity for burning coal, generating steam, and doing work than English engines have.

5. While statistics show that the average amount of fuel burned per train mile is less on English than on American roads, the quantity of fuel, if computed per ton of train hauled per mile, is less here than it is on English roads; and if all the expenses dependent upon the efficiency of locomotives is taken into account it is found that our expenses per unit of weight of train hauled is very much less than theirs. A comparison of the experiments made on the North British and the New York Central roads, in our Table VII, shows that these expenses on the former road were *four times* what they were on the latter.

6. The fact that the average earnings for carrying freight is only a little over a half a cent per ton per mile on our great railroads, whereas a good authority estimates the average rate on British roads at $1\frac{1}{4}d. = 2\frac{1}{2}$ cents, is indicative that the cost of locomotive service is much less here than it is in the United Kingdom.

7. Unless these conclusions are refuted or shown to be fallacious, it will follow that railroad authorities in Canada, and other British colonies, and foreign countries have and will in future show wisdom, and not ignorance or prejudice, as *The Engineer* has intimated, in equipping their roads with American instead of English motive power.

We will add that we have been promised by a locomotive superintendent of one of the principal English railways, full detail drawings of a representative express locomotive, designed and built by him for his line. If these drawings are received, we intend to have them engraved, and give corresponding illustrations of an American locomotive corresponding thereto, with critical descriptions and comparisons. We are now inclined to think that such a series of articles will show our English cotemporaries many features in our engines which they might adopt with advantage, and doubtless there will be much in the practice of our cousins that will be profitable for us to imitate. Should such mutual enlightenment be the result of this series of articles, their purpose will be fully accomplished.

LOCOMOTIVE STEPS.

In the last annual report on the Statistics of Railroads made to the Interstate Commerce Commission by its Statistician, it is shown that 561 railroad employés were killed and 2,363 were injured during the year 1891 by "falling from trains and engines." It is not shown, in this report, how many of these persons were killed or injured by falling from cars and how many by falling from engines. It is not possible to tell, therefore, the relative danger to which those who are employed on the cars and those whose duties confine them to the engine and tender are exposed. But any one who will examine or, better still, will use the steps and hand-rails which are provided for getting on and off of locomotives must, it is thought, be convinced that they expose those who use them to unnecessary risk. A very common form of locomotive steps which is used in this country is shown in fig. 1. These consist of round or oval plates attached by set screws to a vertical rod or bar which is supported by the tail-brace of the engine frame. Usually they are made without any guard around their edges to

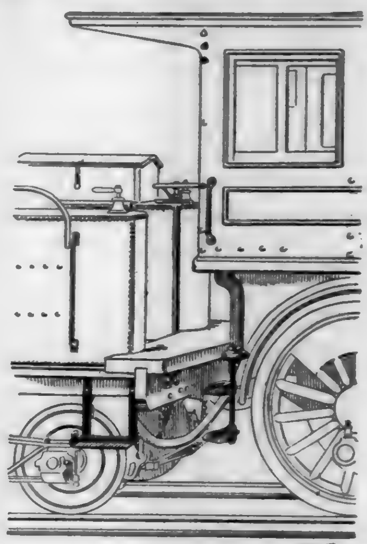


Fig. 1.

prevent a person's foot from sliding off of the step. It is difficult at best to get a firm foothold on a round plate, from the edge of which a person's foot is liable to slip. The danger is increased at night, when it is impossible to see the step distinctly, or in winter, when it is coated with ice. Such steps are usually entirely too small, and there is nothing back of them to prevent a person's foot from getting in behind them in case he misses his foothold. The danger of this is often increased by the height of the step, which is so great as to be difficult to reach when the earth or the ballast slopes downward from the rails where the engine happens to be. Under such circumstances too it is often difficult or impossible to reach the hand-rails or hand-holds on the cab and on the tank.

In the articles which have been published in this and preceding numbers of this Journal we have shown at considerable length wherein American locomotives were superior to those made and used in Great Britain. There is no chance, therefore, of accusing us of prejudice in favor of that which is foreign when we call attention to the greater safety and security to employés which is provided by the steps used on British locomotives compared with those ordinarily used here. Fig. 2 shows a form of locomotive and tender step which is much used on the other side. It will be seen from this engraving that these steps are of liberal size, and are attached to a vertical plate or

riser, so that the foot of a person using them is not liable to slip behind the step in case of missing a foothold. The edges of the steps, too, are turned up with a sort of flange which acts as a guard to prevent the foot from slipping off of the step. The lower step and the hand-rails are

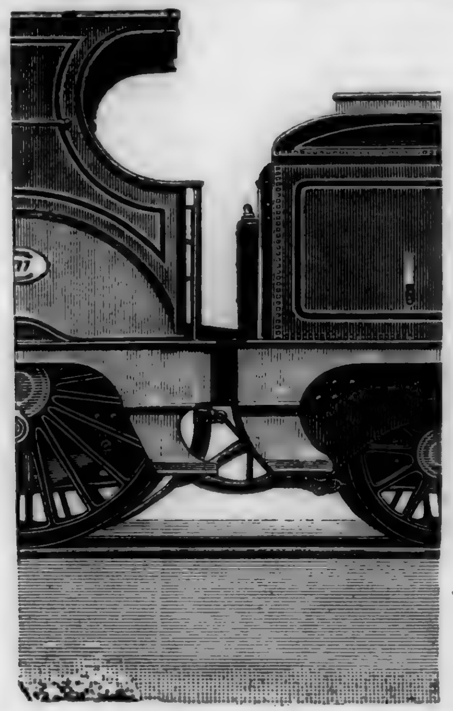


Fig. 2.

lower down than they are in fig. 1, and therefore more convenient to use than the arrangement ordinarily employed on American engines. In the design of these attachments to locomotives, if our builders would imitate English practice it would probably lessen to some extent the many dangers to which those who run locomotives are now exposed, and reduce somewhat the number of accidents to this worthy and courageous class of railroad employés.

RAILROAD STATISTICS.

Third Annual Report on the Statistics of Railroads in the United States. By Henry C. Adams, Statistician to the Interstate Commerce Commission.

FROM time to time reference has been made in these columns to the advantages to be gained by securing uniform and reliable statistics of the railroads of the United States, and also to the steps which had been taken by the Interstate Commerce Commission to secure such statistics. What has been gained in that direction is shown by the advance copy of the report of the Statistician of the Commission for the year ending June 30, 1890, which has just been issued. That over a year has passed since the close of the term covered by the report is due to the many delays necessary in collecting the reports and in properly analyzing and collating the great body of figures assembled.

It is utterly impossible to give a proper summary of the report within the limits of a single article, and the most that can be done is to call attention to its leading features, some of which we hope to be able to refer to at greater length hereafter

A prominent feature of the report is the division of the railroads into ten groups, the statistics of each group being presented separately. The great difference in the density of population, the amount of traffic and the conditions of operation make this method of presentation much more valuable to the student of railroad economics than the plan heretofore adopted of massing the figures for the whole country. How the division has been made and what the groups are is shown at a glance by the accompanying map, which is taken from the report itself. Of course, in any division of this kind there must be some overlapping—that is, there must be some roads which are partly in one group and partly in another ; but the plan adopted is an excellent one, and it would hardly be possible to give a closer classification.

First, however, it may be well to give a few general figures showing the great importance of the railroad interest in this country.

Railroad mileage in the United States on June 30, 1890, was 163 597 miles. The increase in mileage brought into operation during the year was 5,838 miles. Michigan shows the largest increase during the year, being 459 miles, and Georgia comes next, with an increase of 438 miles. Group V, made up of the States of Kentucky, Tennessee, Mississippi, Alabama, Georgia and Florida, shows an increased mileage of 1,370 miles during the year. The total length of track for the United States, including all tracks, sidings and spurs, is 208,613 miles.

The number of railroad corporations on June 30, 1890, was 1,797. Of these 87 are classed as private roads, with a total operated mileage of 812 miles. Nine hundred and twenty-seven of these corporations are operating companies, and 735 are subsidiary companies—that is to say, the mileage which they own is leased to other companies for the purpose of operation. Twenty-two companies, representing a mileage of 1,646 miles, were reorganized during the year, and 34 companies, representing a mileage of 1,906 miles, merged their corporate existence into other corporations. Fifty companies, representing a mileage of 6,196 miles, were consolidated with other companies. Thus 8,102 miles of line during the year disappeared as independent companies.

Forty railroad corporations operate 77,873 miles of line, or 47.51 per cent. of total mileage. The average length of line for these 40 roads is nearly 2,000 miles. There are 75 companies in the United States whose gross income is $846,888,000, out of a total gross income of all railroads in the country of $1,051,-877,632—that is to say, 75 railroad corporations receive 80 per cent. of the total amount paid by the people of the United States for railroad service.

The total number of locomotives in the United States is 29,-928, of which 8,384 are passenger locomotives and 16,140 are freight locomotives. This shows 10 freight locomotives and 5 passenger locomotives for each 100 miles of operated line. The number of cars used on the railroads of the United States is 1,164,188, of which 26,511 are in the passenger service. The number of cars per 100 miles of line is 744. The number of tons of freight carried one mile per freight engine is 4,721,627, and the number of passengers carried one mile per passenger engine is 1,413,142. Figures of this sort measure the economy of transportation by rail. The larger portion of equipment is found on railroads in the Eastern and Middle States. Thus, in the New England States, Group I, there are 28 locomotives per 100 miles of line ; in the Middle States, Group II, 46 locomotives per 100 miles of line ; while in the States west of the Mississippi the number does not exceed 15 locomotives per 100 miles of line. The number of locomotives fitted with train brake is 20,162, and the number fitted with automatic coupler, 955. The number of cars fitted with train brake is 128,241, and the number of cars fitted with automatic coupler is 114,364. When compared with the total number of locomotives and cars, it appears that much remains to be done in the matter of train brakes and automatic couplers.

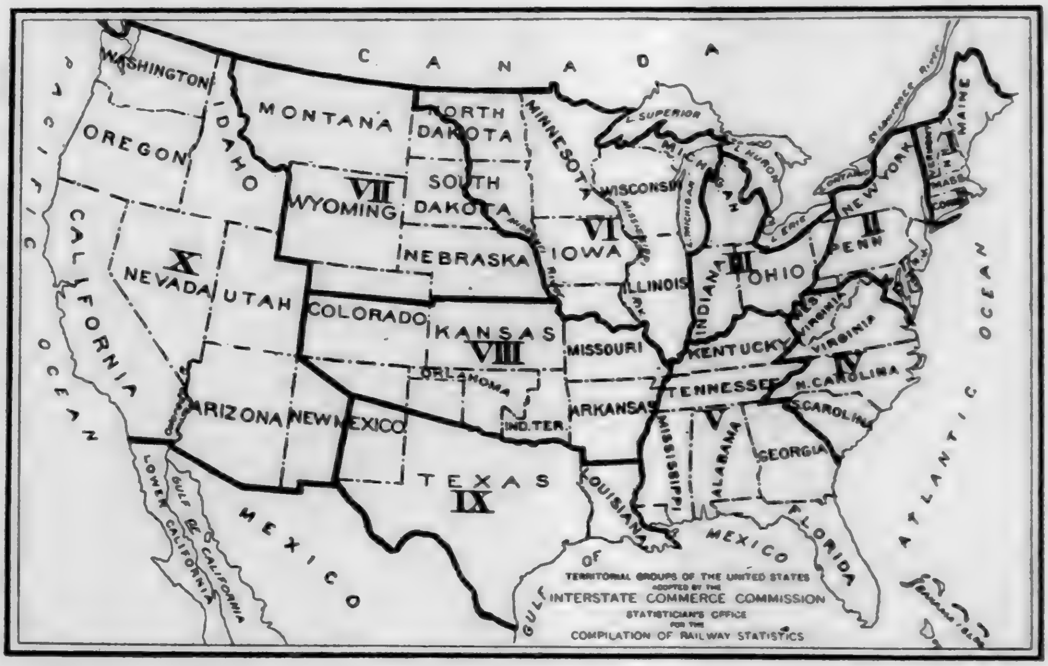
The total number of men employed on the railroads of the United States is 749,301, being an increase of 44,558 over the number employed in 1889. The average number of men employed per 100 miles of line on all roads is 479.

The 156,404 miles of line, which is made the basis of statistics in this report, is represented by railroad capital to the amount of $9,437,353,372, which is equivalent to $60,340 per mile of

COMPARATIVE SUMMARY OF ITEMS, BY GROUPS.

Territory Covered.	Gross earnings per mile of line.	Operating expenses per mile of line.	Locomotives per 100 miles of line.	Men employed per 100 miles of line.	Passenger mileage per mile of line.	Freight mileage per mile of line.	Revenue per passenger per mile. *Cents.*	Revenue per ton per mile. *Cents.*	Per cent. of passenger earnings to total earnings.	Per cent. of freight earnings to total earnings.	Value of property per mile computed at 5 per cent. on earning capacity.
Group I	$10,444	$7,075	28	716	233,530	383,505	1.912	1.373	47.50	51.36	$57,867
Group II	15,829	10,275	46	1,167	183,121	1,348,107	2.029	.828	27.33	70.28	107,741
Group III	7,785	5,322	24	576	85,572	793,763	2.199	.695	28.72	69.33	45,941
Group IV	4,279	2,886	13	379	43,039	330,981	2.481	.844	30.94	66.93	25,177
Group V	4,945	3,278	14	386	46,869	304,936	2.465	1.061	29.16	67.77	30,206
Group VI	5,195	3,324	15	359	50,059	376,403	2.226	.961	26.87	70.97	36,406
Group VII	5,128	3,007	12	328	46,148	269,866	2.452	1.300	27.46	71.19	38,136
Group VIII	4,056	2,613	12	307	37,027	243,753	2.268	1.152	25.96	69.99	27,168
Group IX	4,331	3,278	11	303	33,561	245,732	2.583	1.303	23.88	74.48	14,593
Group X	5,836	3,871	13	250	67,196	191,806	2.308	1.651	34.85	61.74	22,672
United States	6,726	4,425	19	479	75,751	487,245	2.167	.941	29 41	68.23	$42,374

line. Assuming that the remaining mileage is capitalized at the same rate, the total capitalization of railroad property in the United States would be $9,871,378,389. The increase in capital for the year ending June 30, 1890, over the previous year, is $538,079,233. Of this amount $250,000,000 at least is due to the increase in capitalization on lines already in existence. The proportion of railroad capital represented by stocks is 46.73 per cent. of the total. The amount of stock per mile of line is $28,193, and the amount of outstanding obligations, including bonds, equipment trust obligations, etc., is $29,250. There are marked differences in the capitalization of railroad property in various sections of the country. In the Middle States, Group II, for example, capital is outstanding to the amount of $117,902 per mile of line. In California, Oregon, Washington and other States and Territories constituting Group X, capital is outstanding to the amount of $87,104. The roads which converge in Chicago, lying east of the Missouri River—that is, Group VI—are capitalized at $47,645 per mile of line, which fairly represents the capitalization in the other sections of the country, exclusive of the Middle States and the Pacific Slope.



The capitalization of railroad property is largely in excess of its market value. The interest on bonds and the final net earnings available for dividends may be accepted as the amounts accruing to the owners of railroads on their investment. The amount paid in interest was $229 614,470; the final net earnings were $101,758,587. If the sum of these amounts be capitalized at 5 per cent., it shows that the value of railroad property, considered as an investment, estimated on the operations for the year ending June 30, 1890, was $6,627,461,140, which is equivalent to $42,374 per mile of line.

The total amount of earnings and expenses for the whole country was:

	Total.	Per Mile of Road.
Earnings	$1,051,877,632	$6,726
Operating expenses	692,093,971	4,425
Net earnings	$359,783,661	$2,301
Per cent. of expenses to earnings	65.8	....
Interest paid	$229,614,470	$1,468
Dividends paid	89,688,204	574

The total traffic of all the roads for the year is given in the following table:

	Passenger.	Freight.
Train mileage	285,575,804	435,170,812
Passengers and tons carried	492,430,865	636,541,617
Passenger and ton miles	11,847,785,617	76,207,047,298
Average train load	41 passengers.	175.12 tons.
Average haul	24.06 miles.	119.72 miles.

The figures for average haul or journey show the great preponderance of local traffic, in spite of the amount of through

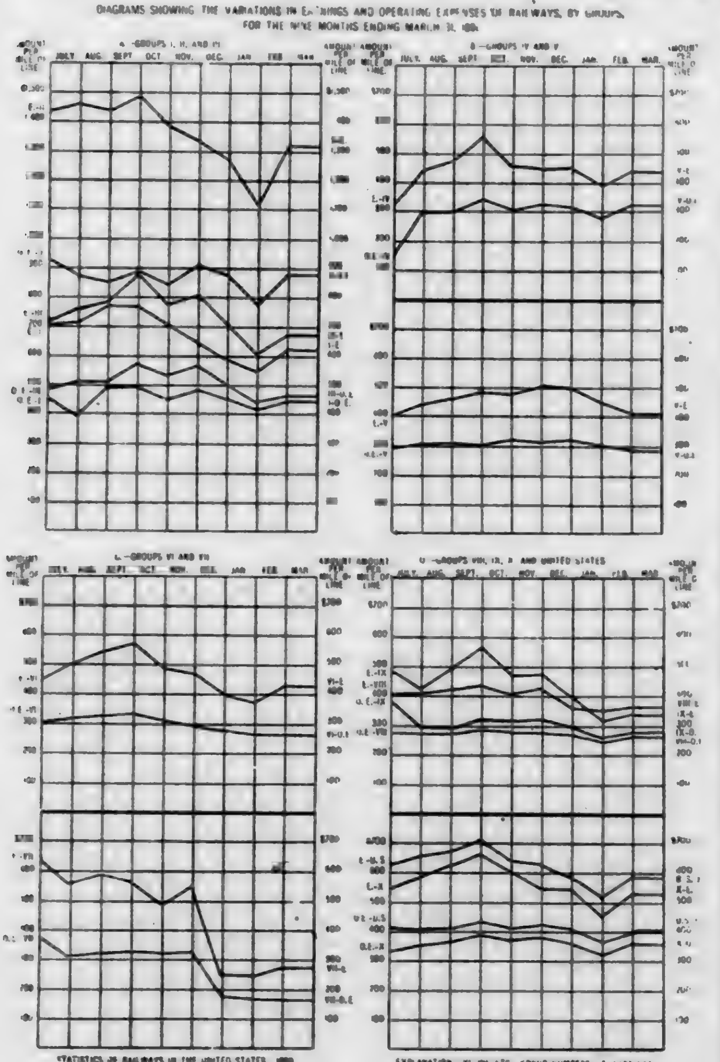
business which is undoubtedly done. Nevertheless, the fact remains that the local business is the mains ay, and where that is greatest the railroads are most prosperous.

The amount paid for rentals does not appear in the statement as given here, except so far as it may have been disbursed as interest and dividends for the lessee companies. The surplus from operations, after paying all charges, appears from the figures in the report to have been $12,070,383.

For the whole country the earnings per passenger mile were 2.167 cents, and per ton-mile 0 941 cent. These figures and averages, however, can best be shown by groups, which is weldone in the accompanying table, taken from the report.

In addition to the information for the year covered by the full report, the Statistician has collected monthly reports of earnings from a large number of companies for the nine months from July 1, 1890, to March 31, 1891, thus practically bringing up certain of the figures to the latter date. Many companies object to monthly statements, believing that they give an incorrect idea of the business of the road, and while we think this is a mistaken idea, it has considerable effect. In the report the results obtained from these monthly statements have been embodied in a graphical form. The accompanying diagrams,

DIAGRAMS SHOWING THE VARIATIONS IN EARNINGS AND OPERATING EXPENSES OF RAILWAYS, BY GROUPS, FOR THE NINE MONTHS ENDING MARCH 31, 1891.



STATISTICS OF RAILWAYS IN THE UNITED STATES, 1890. STATE COMMERCE COMMISSION.

EXPLANATION.—VI, VII, ETC., GROUP NUMBERS. E, EARNINGS. O. E., OPERATING EXPENSES.

taken from the report, show the fluctuations month by month for the roads reporting in each group and for the whole country.

In fuller explanation of the diagrams, perhaps it should be said that each one of the nine columns, when read vertically in any diagram, represents the month named at the top of the column. It will be observed, also, that the "Amount per mile of line" increases at the rate of $100 per square when read from the bottom. Other designations printed on the left and right of each diagram are for the purpose of determining the group (I, II, III, etc.) covered by the irregularly drawn lines, and whether earnings (E), or operating expenses (O. E.), are represented. In reading the illustrations, there should in each instance be compared with the line representing the *earnings* of any particular group the corresponding line representing the *operating expenses* of the same group. In glancing at the line representing earnings for any group for the various months, the influence of harvests and of seasons is clearly shown. Thus, there is to be observed a marked falling off in the months of January and February, while the months of September and October, as a rule, appear to be the most favorable for railroad operations.

Not the least interesting part of the report is that relating to accidents. The total number of persons killed or injured on the railroads for the year may be stated as follows:

	In train accidents.	In operating trains.	At stations, crossings, etc.	Total.
Employés:				
Killed	531	1,019	901	2,451
Injured	2,588	10,550	9,258	22,396
Passengers:				
Killed	113	.....	173	286
Injured	1,407	.....	1,018	2,425
Other Persons:				
Killed	346	....	3,252	3,598
Injured	492	....	3,714	4,206
Total:				
Killed	990	1,019	4,326	6,335
Injured	4,487	10,550	13,990	29,027

The most common cause of accident to employés was in coupling cars, in which 369 were killed and 7,473 injured. A very large proportion of the "other persons" killed and injured were trespassers on the track. It will be noted that the proportion of killed among these is very large. An analysis of the report on accidents must be deferred at present, as it is impossible to present it properly in the present article.

The report suggests that the Interstate Commerce Commission recommend Congress to amend the law, so far as statistics are concerned, in three particulars. It suggests, first, that statistics be collected from express companies, which, under the present interpretations of the act, are free from control. The express companies of this country pay to railroads as rentals $20,277,711 a year. They are in reality engaged in the business of quick delivery of freight, and as such should be amenable to control.

It is suggested, in the second place, that the Commission should have the right to call for reports from corporations engaged in the transportation of passengers and freight by water. In 1889 the Great Lakes carried freight which was the equivalent of 22 per cent. of the ton-mileage on all railroads. The shipping lines on the Atlantic seaboard are in many cases links of railroad systems. It is impossible to present comprehensive statistics of transportation unless these lines be called upon for reports.

The third suggestion is, that reports be called for from all companies furnishing rolling stock to railroad corporations, and from all companies providing terminal facilities. These companies own an enormous amount of property, which is property devoted to the business of transportation. It is impossible to make a complete exhibit of the business of transportation unless they make report.

NEW PUBLICATIONS.

THE GREAT LAKES PROBLEM; OR, THE TWENTY-FOOT CHANNEL. By W. A. Livingstone. Detroit, Mich.

This pamphlet, which was especially prepared for the recent Deep Waterways Convention, is a presentation of the importance of the commerce of the Great Lakes, and of the advan-

tages to be secured by the maintenance of a 20-ft. channel and other improvements. It is largely statistical, but the figures are well presented, and a strong argument is made in favor of the betterments proposed.

The pamphlet has also a number of engravings and descriptions of lake carriers, including some of the largest vessels employed.

FIFTH BIENNIAL REPORT OF THE STATE ENGINEER TO THE GOVERNOR OF COLORADO. J. P. Maxwell, State Engineer. State Printers, Denver, Col.

This report, which covers the years 1889 and 1890, is largely devoted to irrigation and the water question, these including the chief work of the State Engineer. A large amount of information has been collected respecting irrigation works completed and in progress, and also in relation to the rivers of the State and their use as sources of water-supply. Much work was done in gauging the flow of streams, and in ascertaining their capacity.

Irrigation was not the only work done, however, and the report refers to State roads and bridges, and to surveys made for the purpose of settling the boundary lines of several counties as well.

PROCEEDINGS OF THE TWENTY-SECOND ANNUAL CONVENTION OF THE MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF THE UNITED STATES AND CANADA. Published for the Association by the *House Painting and Decorating* Publishing Company, Philadelphia.

This volume contains a full report of the proceedings of the convention named, which was held in Washington in September last. It is published in a neat volume, bound and convenient for preservation. The Association is a hard-working one, and its proceedings always contain some papers and discussions of value in their special field. The present volume is no exception, and there is much in it that is worth preserving.

INDEX TO THE FIRST TEN VOLUMES OF SCRIBNER'S MAGAZINE. Charles Scribner's Sons, New York.

The publishers of *Scribner's Magazine* have marked the close of its fifth year by issuing a complete index to the 60 numbers or 10 volumes of the magazine which have so far been issued. This is prefaced by a brief literary and artistic history of the magazine. It will be a very useful help to those who have preserved a file, or who are interested in consulting the magazine for any purpose.

RAILWAY RATES AND GOVERNMENT CONTROL: ECONOMIC QUESTIONS SURROUNDING THESE SUBJECTS. By Marshal M. Kirkman. Rand, McNally & Company, Chicago and New York.

It is quite natural that any one who has made such a careful study of railroad business as Mr. Kirkman has, and who has had so much to do with rates and their results to the railroads, should write upon this subject. It is perhaps natural also that any one in his position should take very strong ground against any control on the part of Government over the making of rates. Not every one will agree with him on this point, and his ground is certainly too advanced, but Mr. Kirkman has reasons for the faith which is in him, and does not hesitate to give them.

It is beyond question that some control is necessary; to a certain extent he is right in deprecating too much interference by Government, but to leave the entire control of the public transportation business to corporations is something which cannot and ought not to be expected from the people after the hard experience which we have had in this country.

That Mr. Kirkman's book is an interesting one need hardly be said. It includes chapters on the Ethics of Transportation; the Basis of Railroad Rates; Special Rates; Pools; Private Ownership; the Limitation of Government Supervision; the Tendency of Government Supervision; the Distinction between Local and Through Traffic and on several other points connected with rates. It has also an appendix giving a condensed statement of the methods pursued in foreign countries, and especially in France and Germany, where the railroad systems are either owned or entirely controlled by the Government. As a fair and reasonable statement of the railroad side of the question, the book is worth reading.

TENTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1888–89. J. W. Powell, Director. Government Printing Office, Washington.

Part I. of this report, which relates to the Geological Survey proper, shows the usual record of work done, and the advance made, both in the topographical and the geological work. As the surveys extend greater progress becomes possible, especially in determining the correlation of rocks—that is, the relations among widely separated rock masses. The progress made in geological science is also an assistance in making possible better application of the work done; while, on the other hand, it may be said that the progress of the science has been materially aided by the operations of the Survey.

The special reports accompanying this volume are on the Fresh Water Morasses, with a special description of the Dismal Swamp region; on the Penokee Iron Range in Michigan and Wisconsin, and on the Fauna of the Lower Cambrian Zone. They are all elaborate and carefully worked out monographs, and are accompanied by many illustrations.

Part II. contains the first yearly report of the Irrigation Survey, which was ordered by Congress in 1888, and which was placed under the direction of the Geological Survey. It shows that during the year an excellent beginning was made, and more progress secured than might have been expected in a new undertaking. This included surveys of streams, lakes, drainage basins, etc.; the measurement of rainfall and river flow and examination of the sources of water-supply. Work of this class was carried on in Montana, Idaho, Nevada, California, Utah, New Mexico and Colorado during the year, and some idea of its extent may be given by the facts that 21,766 square miles were surveyed and 127 sites for large reservoirs selected. This work is now being continued.

TRADE CATALOGUES.

A New Method of Making Conventional Signs and a New Lettering Device for Use on Original Topographical Maps. By J. A. Ockerson, U. S. Assistant Engineer. A. S. Aloe & Company, St. Louis.

This is an account of a simple and convenient device for lettering maps or drawings, and of one for making the conventional signs, shading, etc., on maps; both of them seem well adapted for the purposes for which they are designed, and their use will save the engineer and draftsman much tedious and monotonous work. The circular is accompanied by specimens of the work done.

Illustrated Catalogue of the American Steel Wheel Company. No. 1, January, 1892.

This catalogue gives a list of the manufactures of this company, which include not only car wheels, but also locomotive driving-wheels, wheel centers, locomotive truck wheels, steel draw-bars, gear-wheels and special castings for cable railroads, and, in fact, all kinds of steel castings for railroad work The Company claims that by its methods perfect and solid castings

can be secured, and reports some remarkable tests made of their strength.

Illustrated Catalogue of the Graphite Productions of the Joseph Dixon Crucible Company; Jersey City, N. J.

This catalogue names a great variety of products from the factory of the Joseph Dixon Company. These include graphite lubricator, both dry for shafts, etc., and in the form of grease for car journals and other bearings; graphite paint for various purposes; belt dressing graphite for the bottoms of yachts; graphite for photographers, for electrotypers and for foundry use; stove polish; crucibles; and last the pencils for which the Company has made such a reputation.

In fact, one must look over this catalogue to realize all the various uses to which graphite can be put.

Illustrated Catalogue No. 2. Frogs, Switches, Crossings, etc. The Weir Frog Company, Cincinnati, O.

This second catalogue of the Weir Frog Company shows a great variety of work, including, besides those named in the table, all kinds of track work and material for steam and street railroads, cable railroad work, portable tracks for contractors, and the like. It includes several new devices, among them a new style of crossing; several improved switch-stands and a new pattern of split switch.

This catalogue deserves especial mention for its convenient size and the clearness and excellence of the illustrations. It forms really quite a reference-book for track material of all sorts.

The Track Spike, the Tie and the Splice-Bar. Morris Sellers & Company, Chicago.

This pamphlet is chiefly devoted to the merits of the Greer patent spike, and includes descriptions of a number of tests made to show its superiority over the ordinary track spike. These are illustrated by several reproductions of photographs, a few of which are good, while one or two are not—apparently from defects in the original photographs. The tests show very well, however, the points claimed for the Greer spike. A few pages are devoted to the Samson splice-bar, which is now, however, too well known to require much recommendation.

BOOKS RECEIVED.

Transactions of the American Society of Civil Engineers: Volume XXV, No. 4; *October*, 1891. Published by the Society, New York.

Transactions of the Canadian Society of Civil Engineers: Volume V, Part I, January-June, 1891. Printed for the Society, Montreal, Canada.

Cornell University, Agricultural Experiment Station: Bulletin 33, *Entomological Division. November*, 1891. Published by the University.

Annual Report of the Postmaster-General of the United States for the Fiscal Year ending June 30, 1891. Government Printing Office, Washington.

Cornell University, Agricultural Experiment Station: Bulletin 34, *November*, 1891. Published by the University, Ithaca, N. Y.

Census of Canada, 1891. *Bulletin No.* 3: *Population of the Eastern Maritime Provinces.* Department of Agriculture, Ottawa, Canada.

Fifth Annual Report of the Interstate Commerce Commission: December 1, 1891. Government Printing Office, Washington. Some references to this important report will be found on another page.

Report of Tests of a Single-Expansion Ten-Wheel Locomotive on the Baltimore & Ohio Railroad. By David Leonard Barnes. Reprinted from the *Railroad Gazette* by Burnham, Williams & Company, Baldwin Locomotive Works, Philadelphia.

Machinery Pattern Making; Containing Full-size Profiles of Gear Teeth. By P. S. Dingey. With 376 illustrations. John Wiley & Sons, New York; price, $2.

Vick's Floral Guide for 1892. *Illustrated.* James Vick's Sons, Rochester, N. Y.

CURRENT READING.

THE beginning of the year, as usual, brings a numerous crop of calendars of all sorts, but the good are in larger proportion than ever before. One of the neatest and most artistic is the Columbus Calendar of the Berwind-White Coal Mining Company, which is really a work of art. Some others worthy of mention are those of the Ashton Valve Company and the Brady Metal Company; more might be named if space permitted.

Among the books in preparation by John Wiley & Sons, New York, is THE IRON FOUNDER, by Simpson Bolland, which will soon be published.

With the opening of 1892 the STREET RAILWAY GAZETTE, of Chicago, changed from a monthly to a weekly form; it is now the only weekly paper devoted to this branch. Mr. M. J. Sullivan is now editor, having recently taken charge, and purposes making many improvements. The street railroad interest is an important one, and so good a paper ought to meet with full appreciation and support.

Besides the usual amount of lighter matter, HARPER'S MAGAZINE for February has illustrated articles on the Danube River; on the Fur Trade of the Northwest and the Hudson's Bay region; on the Old Shipping Merchants of New York, and on Chicago, the latter by Julian Ralph.

The OVERLAND MONTHLY for January has a number of illustrated articles, including some very fine reproductions of photographs of the moon taken in the focus of the great Lick telescope. The accompanying paper gives an account of some of the work which is being done at the Lick Observatory. There are several historical sketches of much interest, besides a variety of lighter matter. In the February number there is an illustrated account of the ascent of Mount Conness, by Professor George Davidson, the pictures being from photographs taken by the party. There is also a careful and detailed account of the Temescal Tin Mines, about which so much has been said and so little written with authority.

With the January number the journal INDUSTRY, of San Francisco, changes from a page a little larger than our own to the magazine form. In the new form the page is about the size of *Harper's*, and the number before us has 96 pages of reading matter. This paper has always been one with many ideas, and Mr. Richards never fails to give his readers something worth attention. The magazine deserves the success which we hope it will attain.

No. 4, Volume I of the ROSE TECHNIC, issued by the students of the Rose Polytechnic Institute at Terre Haute, Ind., has several excellent articles, and a variety of matter of interest to graduates of the Institute.

The SCHOOL OF MINES QUARTERLY for November has articles on the Intercontinental Railroad, by C. F. Parraga; the Shadow of a Circle, by A. D. F. Hamlin; Harbor Improvements on the Pacific Coast, by F. X. Brosnan; the Filling of Mineral Veins; Mine Ropes and the Frankfurt Electrical Exposition.

In HARPER'S WEEKLY for December 26 there was an excellent illustrated article on the work now in progress on the power tunnel at Niagara. In the number for January 2 there is an account of the new Drexel Institute in Philadelphia, with a

number of pictures of the Institute. In this number also there is an account of a successful experiment in cultivating lands on Long Island which had always been considered barren and worthless. The number for January 9 has an interesting article on the Revenue Marine and its work, the extent and variety of which is not generally appreciated.

The opening article in the POPULAR SCIENCE MONTHLY for February is on Personal Liberty, by Edward Atkinson and E. T. Cabot It treats of the labor question, giving the results of an exhaustive examination of the decisions of the courts concerning restrictions on hours and modes of labor, regulation of the method of payment, etc. The Pottery articles are continued. The fourth of the Lessons from the Census, by Mr. Carroll D. Wright, is on Urban Population. Professor Jordan writes of the Yellowstone Park, and there are other articles of interest.

The number of the ENGINEERING AND MINING JOURNAL for January 2 is the yearly statistical number; it has 78 pages of reading matter, containing a great variety of statistics of metal and mineral production, the markets for 1891 and similar matters.

The Annual, published on January 1 by the TRADESMAN, of Chattanooga, Tenn., is a valuable number, containing much information about the industries of the South and their growth during the past year. Especial attention is called to the development of the coal and iron industries, and to the great increase in the number of small factories of different kinds.

The special articles in the February number of SCRIBNER'S MAGAZINE include a description of the great Sheep Ranches of Australia, by Sidney Dickinson; an account of the work of the Revenue Marine, by Lieutenant P. W. Thompson, and some results of Explorations in Greenland, by Dr. Benjamin Sharp. The other articles are fully up to the usual standard.

The recent earthquake in Japan is treated in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for January. There are also articles on Lake Bonneville, on the Names of the Mississippi, on Maps and Map Drawing, and a variety of other topics. The editors evidently believe in short articles, and there are several in this number so interesting that the reader is inclined to wish they were longer.

The February ARENA has articles on the Railroad Problem, by ex-Governor Lionel A. Sheldon; on the Sub-Treasury Plan of the Farmers' Alliance, by C. C. Post, and on the Electoral College, by R. S. Taylor. There are a number of other articles deserving attention in the number.

The JOURNAL of the Military Service Institution for January has articles on the Terrain in Military Operations, by Lieutenant Reed; A United States Army, by Lieutenant Batchelor; Rapid-Fire Guns, by Lieutenant Van Deusen; Discipline and Tactics, by Captain Harris; Reminiscences of Tonquin, by Lieutenant Cloth. There are also a number of reprints and translations of interest.

In the COMPASS for January there are articles on Speedy Calculators; on the Plain Transit; on Position Finders, and a continuation of the very interesting papers on Series of Numbers.

Among the articles in the ENGINEERING MAGAZINE for January are the World's Store of Tin; Art and Engineering at Tuxedo Park; the Rights of the Lowest Bidder—an interesting subject for contractors; the Paper Making Industry; Sewage Disposal; Type-setting by Machinery, and the second of Dr. Coleman Sellers' papers on American Supremacy in Mechanics.

A NEW venture in the magazine field is GOOD ROADS, the first number of which was issued in January, by the League Roads Improvement Bureau, under the editorship of Mr. Isaac B. Potter, and which is to be devoted to the cause of better roads. The first number contains a variety of excellent matter, including a number of engravings taken from photographs and showing the actual condition of some common roads, which is contrasted by showing highways in England, France and Italy. There are several articles on the road question, including one on the Personal Labor Tax System. This magazine has a large field before it, and can do excellent work and promises well for the future.

The number of the AMERICAN AGRICULTURIST for January marked the beginning of the second half century of that excellent periodical. It is a very handsome number, with a large number of engravings, and contains, besides the articles which will interest readers generally, a valuable statistical review of the crops and live-stock of the country, past and present, including a number of new figures from the last Census. A careful estimate of the prospects for the future, with especial reference to the farmer, is another article which will attract attention. Age, apparently, has only increased the vigor of our contemporary.

THE BERLIN BRIDGE COMPANY'S SHOPS.

To those not familiar with the location of this enterprising Company's establishment, nor with Yankee geography, it may be said that Berlin, or Berlin Junction is a station on the New York, New Haven & Hartford Railroad between New Haven and Hartford. This, however, is not the location of the shops referred to. They are at East Berlin, a flourishing village on the Middletown Branch of the New York, New Haven & Hartford road, and about five miles from Berlin.

These shops are organized for doing iron bridge, roof, and building work, and are admirably adapted for that purpose. Between 300 and 400 men are now employed, and about 20 draftsmen. Everything about the establishment is thoroughly systematized. When an order is received it is assigned a number and entered on a book in which the principal dimensions and the chief characteristics of the work are entered. It then goes to the drawing-room and is completely worked out in all its details. A little book accompanies the drawings into the shop in which all pieces are entered with their dimensions. This forms a guide in getting out the work and also in shipping it.

When the drawings go into the shop they are taken first to the template floor. This is a large shop with abundant floor room on which the roof or bridge is laid out full size, and wooden templates are made of all the parts, with rivet holes bored and dimensions and other particulars marked on them. This is not required for certain kinds of work, such as pin-connected bridges, but all riveted structures are laid out in this way.

The principal feature of interest, however, to a visitor to this establishment, is the new bridge shop, which is a model of its kind. It is 80 × 400 ft., with an annex which forms the boiler and engine-house. Narrow-gauge tracks extend through the shops longitudinally, and are connected with the other shops and yard. The first stage in getting out work is to lay it off from the wooden templates. Each hole is marked with a punch, the number of the job painted on the plate bar, or "shape," and other facts of importance are indicated. The members then go to the shears, which are located at the north end of the building, and are cut to the required form and size. They are then moved southward to the punches, after which they are assembled and riveted together. After they are punched they are carried on tracks elevated about two feet and a half above the floor, or at a convenient height for the workmen.

The lower chords of the roof trusses are formed of built-up I beams, which carry transverse trolleys for moving heavy parts. Longitudinal tracks are also supported from the roof and carry trolleys, so that any part of the floor can be reached by the two systems. The south end of the shop is provided with small traveling cranes carried

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BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

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A very commendable feature in this shop is the great amount of light which is provided. The roof trusses are supported by built-up wrought-iron columns, and all the space between them, excepting that about eight feet from the floor, is enclosed by window sashes. The space below the windows in winter is enclosed by removable wooden sections which are put up in winter and taken down in summer. Besides these windows there are abundant skylights glazed with ribbed or "hammered" glass to exclude sunshine. This building shows the impossibility of getting too much light into a workshop. It is difficult to emphasize too much the importance of an abundance of light in such buildings. Insufficient light is one of their most common defects. It seems as though most of those who design shops "love darkness better than light."

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THE accompanying illustration is from a photograph of a very heavy locomotive recently built by the Rogers Locomotive & Machine Works, Paterson, N. J., for the Chicago, Burlington & Quincy Railroad, for service as a pusher or helping engine on a heavy grade, and now employed in such service on the Burlington & Missouri River Division of that road.

Among the peculiar points of the engine may be noted the absence of a truck, throwing the entire weight on the driving-wheels; the large boiler capacity; the use of the Belpaire fire-box, in which the crown-bars are dispensed with and the fire-box crown-sheet supported by radial stays to the outer shell; and the large grate area.

The boiler of this engine is 68 in. diameter of barrel at the smoke-box end; it has 229 tubes 2½ in. in diameter and 14 ft. 6 in. long. The fire-box, which is, as noted above, of the Belpaire type, is 11 ft. long by 41 in. wide inside; it is 61⅝ in. in depth at the front end, and 59⅛ in. at the rear end. The grate area is 37.5 sq. ft.; the heating surface is: Fire-box, 180 sq. ft.; tubes, 2,172 sq. ft.; total, 2,352 sq. ft. The fuel used is Iowa coal. The usual working pressure is 160 lbs.

The entire weight of the engine is carried on the 10 drivers, which are 50 in. in diameter. The wheel centers are 42 in. in diameter, and the tires, of steel from the Latrobe Works, are 4 in. thick. Eight of the wheels have flanged tires; the tires of the middle pair are plain, and are 6¾ in. on the face. The total wheel-base is 17 ft. 10 in., and the wheels are spaced equal distances apart. The driving axle journals are 8 in. in diameter and 8¾ in. long.

The parallel rods are of the solid-end pattern, bushed. The main connecting rod is fluted, and of the usual strap end pattern. The driving-springs are from the A. French Company. The cross-head is of the "alligator" pattern, with the guides above and below, as shown.

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The smoke-stack base and cylinder head covers are of pressed steel. The engine is fitted with the Westinghouse automatic tender and train brakes, and with the American equalized driver brakes.

The total weight of the engine light is 134,000 lbs. The total weight in service is 150,300 lbs., giving an average of about 7½ tons per wheel.

The tender is carried on two four-wheeled trucks. The tender axle journals are 4¼ in. in diameter and 8 in. long. The tank has a capacity of 3,480 gallons of water.

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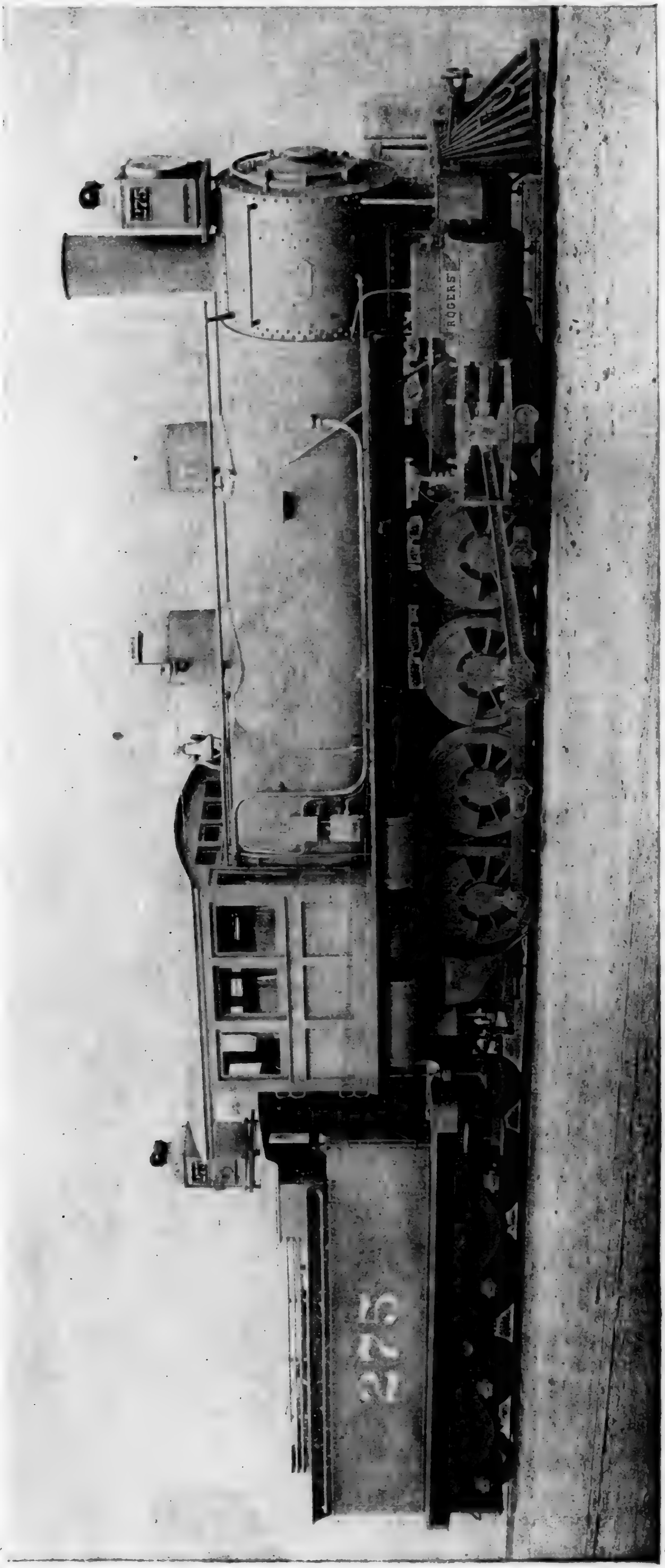

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the high-pressure being 7 in. in diameter and the low-pressure 14 in. in diameter, having a stroke of 16 in. In this system we are enabled to get up a vacuum in the cylinders before the engine is started, thus relieving the pressure of the atmosphere from the other side of the pistons. This cannot be obtained in an air-pump attached to the main engine before the engine is started.

The seats for the salt-water valves in the circulating pump are formed in solid composition plates instead of seats driven into cast iron. The piston and piston-rods are of composition, and the air and water cylinders are lined with composition. This extra amount of valve area permits the pumps to be run at a high rate of speed.

The valves for the main engine are of the piston type, set with a travel of 14 in. for the high-pressure cylinder, and 18 in. for the low-pressure cylinder. They are worked by the Stephenson double-bar link, which is connected to the rocker shaft by means of a rod attached to each side of the link, and in turn connected to an arm keyed on the shaft.

The initial steam pressure in the main engines will be 125 lbs. to the square inch, furnished from two horizontal boilers 9 ft. 1 in. in diameter and 21 ft. long. Each has two corrugated furnaces 44 in. in diameter. The total grate surface is 100 sq. ft. The boilers were tested to 250 lbs. hydrostatic pressure. The shell is composed of ⅞-in. steel. The tubes are 2 in. in diameter. In a short time, when the engines get settled down, the steam pressure may be reduced to 85 lbs. pressure to the square inch.

The reversing engine is placed in front of the main engine, parallel, and bolted to the engine column. It is operated in the ordinary manner.

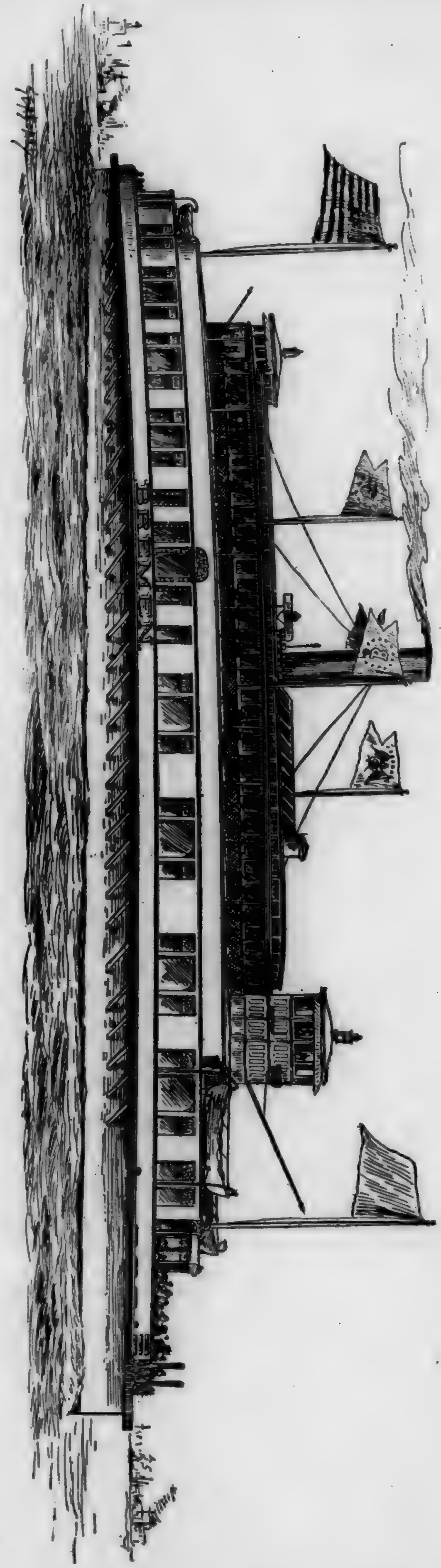
The steam for the main engines is regulated by two balanced throttle valves in the steam pipe, one leading into the high-pressure cylinder of each engine. The throttle lever is attached to a shaft working in four bearings, which are bolted to the cylinders; the shaft runs from one high-pressure cylinder to the other, where, by means of a lever at each end, attached to arms keyed on the shaft, it transmits motion to a small shaft working in a bearing, which in turn regulates the valve. By moving the throttle lever, which is connected to the shaft, steam enters both high-pressure cylinders at the same time.

The diameter of the crank-shaft is 9½ in., which runs the entire length of the boat. The cranks are placed 180° apart in each engine, so that when the engines are coupled together the center line of cranks in one engine will be perpendicular to the center line of cranks in the other, so that, practically, the cranks stand 90° apart. With this arrangement, smoothness of running is assured, while the engines can be started from any position, it being impossible to be caught on the centers. There is also little vibration felt, owing to the fact that each crank balances the other.

The steering gear comprises two Williamson steam-steering gear, one placed in the forward compartment of each boat. Each engine has two cylinders, the cranks being set 90° apart. By means of gear wheels a drum is revolved around which chains are wound, leading in opposite directions, working on slides. A number of small pulleys communicate motion to a large wheel of about 60 in. in diameter which is fastened perpendicularly to the rudder post, the chain in turn passing around the wheel. The rudder is of the balanced type, the hull being cut away to receive it. The front end of each rudder is cut on a line with the bow, giving an easy and graceful curve, and practically forming a part of the bow. With a rudder of this type it is obvious, providing enough power is applied to it, the amount of water dispensed with on either side is greater than that of a rudder half out of water.

The trial of the *Bremen* has already taken place. The trip comprised, to Newburg and return, a distance of about 120 miles. The indicated horse-power developed registered 1,475 maximum. A mile was made in 3 minutes 7 seconds. While in service on the ferry she will develop about 750 I.H.P.

These engines were built by the W. & A. Fletcher Company, of Hoboken. To these successful engineers great credit is due for the successful performance of this boat. The pumps, etc., were furnished by the Blake Manufacturing Company, of New York.



DOUBLE-SCREW FERRYBOAT "BREMEN," HOBOKEN FERRY.

THE BEDFORD PARK FOOT-BRIDGE.

THE accompanying sketch shows a very neat foot-bridge which has lately been erected at Bedford Park station, on the Harlem Division of the New York Central & Hudson River Railroad. Bedford Park is one of the prettiest of the recent suburban settlements around New York ; it is on the west side of the Harlem Railroad, just above the old village of Fordham, while on the east side of the road is the new Bronx River Park, owned by the city of New York.

The station is on the west side of the railroad, which has at that point four tracks, the two outer ones being used by the local trains, which stop at the station, and the two inner ones by express trains. The north-bound platform being on the east side of the tracks, a bridge was necessary to enable passengers to cross in safety, and one has been built, which is shown in the sketch, and which harmonizes well with the station and its surroundings.

FOOT-BRIDGE AT BEDFORD PARK STATION.

The bridge is a single span of 60 ft.; the two plate girders are supported on two columns at each end. The girders, which are spaced 8 ft. 6 in. apart between centers, form the railings, and the floor is carried on the lower flanges. The stairways on either side are supported by cast-iron columns. The bridge itself and the stairways are covered by a roof of ornamental design, carried on light iron columns.

This station, it will be noticed, is fenced in, and fences are placed to prevent persons from crossing the tracks on a level. This is the general practice followed on the Harlem line at the suburban stations.

In addition to the usual local traffic at this station, there is in summer a large number of passengers going to and from the Bronx Park ; this is likely to increase, as the park becomes better known and the plans for its improvement are carried out.

A THERMO-ELECTRIC METHOD OF STUDYING CYLINDER CONDENSATION IN STEAM ENGINE CYLINDERS.

(Paper read by Professor Edwin H. Hall before the American Institute of Electrical Engineers ; from the *Transactions* of the Institute.)

THE subject of cylinder condensation is one that possibly would come more aptly before the mechanical engineers than before the electrical engineers, and yet most electrical engineers are to a greater or less extent mechanical engineers, and the time seems not yet to be near when we can dispense with the steam-engine in the practical application of electricity. The methods for turning the energy of coal directly into electric currents, I believe, have not yet been put into application. The subject of cylinder condensation is one that has always been prominent in the study of the steam-engine. Before the time of James Watt, as you are all aware, at every stroke the cylinder was filled with steam and then it was cooled down by pouring water on the outside or by admitting water into the inside, so that whenever the steam was admitted it found the cylinder cool. A large part of the steam admitted at every stroke was turned into water at once on admission, and some of it was doubtless turned back into steam during the stroke, but much of it went out as water in the end. Watt introduced the independent condenser by means of which the steam is removed from the cylinder without cooling the latter down as it was cooled before ; and yet, it is still believed that a very considerable part of all the steam that enters the cylinder is condensed upon the inner surface of the cylinder ; that some of this is reevaporated during the stroke, but that a very considerable part remains as liquid at the end of the forward stroke and is only turned back into steam during the back stroke, when it is a disadvantage rather than an advantage, for it has to be expelled by the returning piston. It is considered that in some engines as much as 25 per cent. of all the steam that enters the cylinder goes through the cylinder as water—that is, during the forward part of the stroke. Writers upon steam engineering have devoted a good deal of attention to discussion of the cause of cylinder condensation, with perhaps less attention to suggestions for remedy. The cause of cylinder condensation is that when the cylinder is thrown into communication with the condenser, rapid evaporation takes place of the water remaining on the wall, and that rapid evaporation under the diminished pressure cools greatly the cylinder wall.

A little over two years ago Mr. Dickerson, of New York, gave an address before the Electric Club, in which he advanced the proposition that the peculiar character of the indicator card of a steam-engine, which was supposed to show cylinder condensation and re-evaporation, was due to leakage by the valves—leakage in at one part of the stroke and leakage out at another. He made the statement that steamboats in the waters about New York would travel four or five miles an hour with the valve between the boiler and the cylinder closed. I do not know how accurate that statement was, but I have never seen it contradicted.

Interest was excited by this paper, and I knew that steam engineers were by no means agreed as to the amount of

condensation, or as to what caused the cylinder condensation, some believing that the steam coming in at *A*, fig. 1, was cooled by contact with a layer of water remaining over from the previous stroke—the layer of water upon the inside of the cylinder. They thought that you could hardly account by the action of the iron alone for the very sudden condensation of the large amount of steam that is condensed. Mr. Dickerson's paper, then, stimulated me to undertake an investigation of this matter in a direction

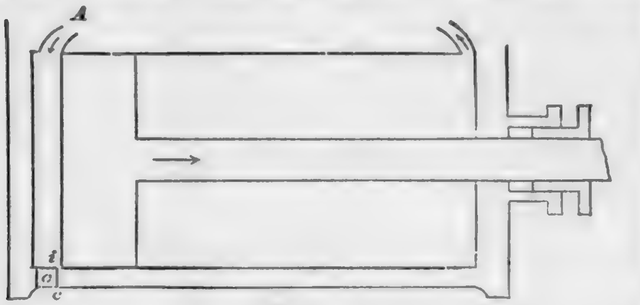
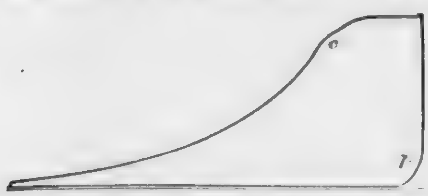


Fig. 1.

in which it had not been approached before, so far as I known. Steam engineers have invariably, so far as I know, examined this question by study of the indicator card, examining the pressure at different parts of the stroke—the pressure and volume—and finding out how much steam they indicate. Knowing the pressure at this part of the stroke *C* (fig. 2), and the volume occupied by the steam, we can tell what weight of steam there is in the cylinder as *steam*. It is found frequently that there is

Fig. 2.



more steam in the cylinder at the end of the stroke than at the beginning of the expansion. According to Mr. Dickerson, that was due to the leakage by the valves by which steam was admitted, when the pressure in the cylinder fell low. It seemed to me that we might test the question how much heat enters the cylinder wall by a thermo-electric method. Let the line *i e*, fig. 1, represent the thickness of the cylinder wall. At *O* is a hole which in the engine which I have used is bored for attaching the indicator. It is a hole about ¾ in. in diameter. The thickness of the wall is a little over ¾ in. I screwed a plug, fig. 3, having at one end *i*, a slice of iron—I used steel at first—of known thickness. There are two holes going through

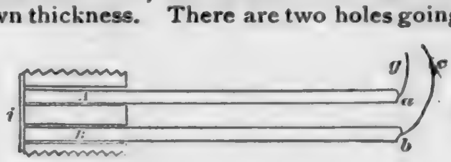


Fig. 3.

the plug to the slice of iron; into one I put a bar of antimony *A* and into the other a bar of bismuth *B*, both being insulated from the plug. It is well known that bismuth and antimony make an excellent thermo-electric pair—the best that is in practical use. If I connect the antimony with the copper wire *g*, the bismuth with the copper wire *c*, and lead those wires to a galvanometer, I shall get a current through that galvanometer whenever the two junctions here, *a* and *b*, are at a different temperature from the section where the antimony and the bismuth strike this slice of iron. If I put the ends of these rods of bismuth and antimony into a pot of paraffin and heat that paraffin, when I get the temperature of these two junctions, *a* and *b*, where the copper joins the bismuth and antimony, the same as the temperature where the antimony and bismuth strike the iron, the current will cease. If the temperature here is below the temperature there, I get the current in one direction. If the temperature here is higher than the temperature there, I get a current in the opposite direction.

That was the beginning of the method. But it presently occurred to me that it would not do to use bismuth and antimony, for the reason that the heat conductivity of those substances is too different from that of iron. My purpose was to find what the temperature was at a certain thickness in the cylinder wall at a certain part of the stroke. I close the circuit *g c* at a particular part of the stroke by means of a cam upon the crank. I can close the circuit at any part of the stroke for a short time.*

It being my purpose to find what the temperature is at a particular depth in the iron, I wished to have that temperature as exactly as possible what it would be if this iron were in a normal condition—that is, if this were in a solid cylinder instead of being in a prepared plug. To get that I found it necessary to have for the bars, *A* and *B*, fig. 3, a heat conductivity which was more nearly like that of iron than the heat conductivity of antimony and bismuth is. So I cast about for some metal which would *with iron itself* make a good thermo-electric couple, and of which the heat conductivity would be very like that of iron. Nickel suggested itself. Nickel and iron make a very good

Fig. 4.

thermo-electric pair. I determined to make my plug in this way. In fig. 4 is a plug with a hole bored completely through it. *S* is a slice of cast-iron ground to a particular thickness, which is screwed on at the end of the plug, making a joint meant to be steam-tight.†

Into this hole I put a core of nickel insulated from the iron except where it strikes the slice. The nickel is soldered to the iron. The slice is tinned very thinly; the end of the nickel core is also tinned. The two are heated very hot and then they are held together in a vise until they are cooled, so that the thickness of the solder is not more than 0.001 in. The soldering was done with the slice and the nickel core in place, the slice being screwed to the plug and the core being surrounded by a single layer of paper to keep it free from the iron, except at the bottom of the hole. Slice and core were removed from the plug after soldering, and the solder which had been squeezed out from the joint by the action of the vise was carefully turned off in a lathe. The distance from the outer end of the core to the further surface of the slice was measured carefully before soldering and after soldering. In no case did these measurements show the thickness of the solder to be as much as 0.02 mm. We know very definitely, then, the depth at which the contact takes place. By experiment, I found that the heat conductivity of nickel is perhaps 15 or 20 per cent. less than that of cast iron,‡ but still nearer the heat conductivity of cast iron than any other metal that I could get that would make with iron a good thermo-electric junction. The specific heat of nickel is near that of iron, which again is as important, perhaps, as the matter of the thermal conductivity.

Now from the nickel core I led a nickel wire, both being made from the same bar of which I had determined the conductivity; from the iron an iron wire. This and the one of nickel were slender bars about 15 cm. long rather than wires proper; see fig. 4. These are not drawn to scale. The junctions *i* and *n* were put in a pot of paraffin, and I went through the processes which I have indicated already.

I had three plugs like this made. With one the slice of iron was 0.051 cm. thick, with the other, 0.101 cm. thick, with the other, 0.203 cm. thick. Let fig. 2 be the indicator

* In my latest experiments the fly-wheel has made about 60 revolutions per minute, and contact has lasted about $\frac{1}{60}$ part of a revolution. The cam pushes two pieces of brass together without touching either of them directly. Springs hold the two slips of brass apart when the cam is not acting.

† In some of the experiments this joint was not perfectly tight, for *water* was sometimes seen to come out by the *core n* before the plug became hot. Generally upon such occasions the leaking appeared to cease when the plug became hot. The fact probably is that the joint continued to leak slightly, but leaked *dry* steam, the temperature at the outer end of the plug being about 109° C., and at the inner end considerably higher. Both experiment and reason indicate that the effect of such leakage upon the temperature found was slight.

‡ The nickel used was of fair commercial quality. I am not yet prepared to publish details of the measurement of its conductivity.

card from the engine with which we are making this test. I used first the plug with the thinnest slice, and I found the temperature at this depth of iron, ½ mm., at that part of the stroke, *k*, fig. 2, just before steam is admitted. I did the same with the 1-mm. slice and with the 2-mm. slice. Let the line *D*, fig. 5, represent 4 mm. of the thickness of the cylinder-wall, points at depths of ½ mm., 1 mm., and 2 mm., being marked upon it. Now I plot a curve. Let me say that a part of this is prophetic; this curve I haven't been able to plot perfectly. Suppose that distances out to the left from the line *D* represent excesses above 109° centigrade, that being the temperature of the outer surface of the cylinder wall. With the ½-mm. slice at the part of the stroke, *k*, fig. 2, I find an excess above 109° of 8° or 9°, which I will represent by the distance *a*. With the 1-mm. slice I find the temperature to be greater at this part of the stroke, and I will represent the excess above 109° by the distance *b*. With the 2-mm. slice the temperature was not very different from what it was with the 1-mm. Through the tops of the lines *a*, *b*, and *c* I draw a curve. What I wish to do some time is to be able to plot a curve like that giving the temperature all the way down inside the wall of the cylinder at this particular part of the stroke.

I made similar determinations for that part of the stroke *c*, fig. 2. I found the temperature at ½ mm. depth had risen to 131°, more or less. The temperature at the depth of a millimeter was a little higher. This point, ½ mm. deep, had already begun to cool. The fact is that in my engine the cut-off is, as shown in fig. 2, pretty gradual, so that re-evaporation very likely begins before cut-off is complete. I suspect, however, that 131° is too low for the temperature at a depth of ½ mm. At the depth of 2 mm. the temperature was not as high as it was at a depth of 1 mm. At the depth of 2 mm. in the iron there was, however, a jump of some 4° to 5° centigrade.

One of these curves, shown in fig. 5, represents the condition of things at this part of the stroke *k*. The other curve represents the condition at that part of the stroke marked *c*. The curves are by no means accurate and they

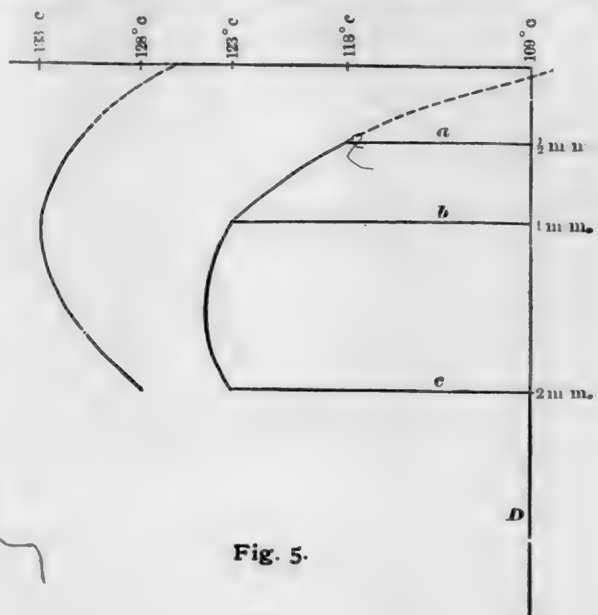


Fig. 5.

are very incomplete, but supposing them made perfect, I have merely to put on a planimeter to measure the area between the two curves, and it is then easy to determine how much the heat in the cylinder at the part *c* of the stroke exceeds the heat at the part *k*, and this excess of heat is the heat which has been given up by the steam to the cylinder wall, which has been done during the admission. Allowance should be made, of course, for the loss through the wall meanwhile. Then I can compare the result with the indicator card and see whether the two are in agreement.

I have made some tests for points at other parts of the stroke. I found, as I have already stated, that at ½ mm. depth the temperature at cut-off has already passed the maximum, that it falls rapidly down here during expansion, and at this part of the stroke near release, it is only a few degrees higher than at the end of the exhaust. But the parts deeper in the cylinder are, of course, slower to cool. In fact, the heat rushes into the wall here during admission; then as soon as the pressure is relieved the water begins to evaporate from the inner wall and the heat ebbs back and is spent, some part of it, in forming steam during the expansion, but not all of it. A considerable part remains at the end of the stroke to be spent in evaporating water which is still clinging to the wall of the cylinder.

As I have said, this research is by no means complete, but it has gone far enough to indicate that a very large quantity of heat goes into the cylinder wall. A very rough calculation from my experiments indicates that in the engine* I am using (Kendall & Robert's 10-in. cylinder with 15-in. stroke); about two-thirds as much steam is condensed upon the cylinder wall as remains active at the beginning of expansion. I should say that two-fifths † probably of all the steam that enters that cylinder is condensed upon the cylinder wall upon the first quarter of the stroke. How much of that is reevaporated during the stroke, and so helps more or less, I do not yet know. According to the indicator cards taken during the experiments with the plugs, the weight of steam in the cylinder at the end of expansion is about 1.25 times as great as just after cut-off. How much heat is absorbed by the layer of water which remains over from the previous stroke, I cannot tell. I think there is some evidence that a layer of water does remain over from the previous stroke. This examination shows, however, that the iron is exceedingly effective in cylinder condensation, and it suggests the question whether it is not possible to coat the inner wall of the engine with something which would prevent, to a considerable extent, this condensation. It is not easy to find anything with which one can coat the rubbing surfaces of the cylinder, but there is the end of the cylinder and there is the face of the piston, and those two surfaces make, in the case of a short cut-off, perhaps more than half the area which is effective in this cylinder condensation. It is not at all impossible that some comparatively non-conducting material can be found with which those surfaces can be coated so as very materially to decrease the cylinder condensation. Experiments for that purpose could easily be made with plugs of this kind. Instead of having to coat the whole cylinder, this plug might have some non-conducting material laid on it, and we might see how much difference that would make in the amount of heat absorbed. Something valuable might come out of it, and a very large aggregate saving in the steam used in steam-engines might perhaps be made in this way.

The research of which I have here given an account has been carried on with money from the Rumford Fund of the American Academy of Arts and Sciences. For indispensable assistance in the investigation I am indebted to Messrs. Barron, Curtis, Hale, Kendrick, and Page, members of a class at Harvard College engaged in a study of the steam-engine.

ARMY ORDNANCE.

THE report of the Board of Ordnance and Fortification, which has been submitted to Congress by the Secretary of War, is dated October 30 last, and states that the total amount appropriated subject to the supervision of the Board to date is $11,385,332, and in addition thereto the sum of $3,500,000 will be required to fulfill the contract with the Bethlehem Iron Company, approved by the Board.

In regard to the Watervliet Gun Factory, the Board says that, when completed, as contemplated by the Act of 1891, the factory will be equipped for manufacturing all calibers up to and including 12 in., and the building will be adapted to receive machinery for finishing and assembling 16-in. guns should Congress hereafter authorize their con-

* This maximum pressure I get here, fig. 2, is about 33 lbs. above atmospheric, and I use an expansion of about 3¾ and about 60 strokes to the minute.

† This is very likely an overestimate; perhaps one-third would be safer.

struction. The Board has carefully considered this question of additional machinery, and is strongly of opinion and recommends that it should be of a size adapted to finish and assemble the 16-in. gun.

Contracts have been entered into for 73 sea-coast mortars, and the sum of $325,000 has been appropriated for the construction of carriages for the same. The modern high-power breech-loading rifled mortar, of about 12-caliber length of bore, being an entirely new arm in our service, carriages of greater strength and endurance than any heretofore in use, capable of resisting the immense strain of firing a projectile of upward of 600 lbs. weight at a great angle of elevation, had to be devised, constructed, and tested. Two types of carriages for these heavy rifled mortars, which are to constitute such an important part of our system of defense, have been purchased under allotments recommended by the Board, and both are now at Sandy Hook. In conclusion the report says:

"There are now certainly two great plants where forgings up to 12-in. guns can be turned out with reasonable dispatch, and a gun factory where they can be finished and assembled. Types of 8-in., 10-in. and 12-in. guns have been completed, and either tested or are awaiting proof. It is expected that by January 1, 1893, the factory will have turned out nine 8-in., five 10-in. and two 12-in. guns. Eleven guns of 8-in. caliber are under contract with the West Point Foundry. One hundred guns of 8-in., 10-in. and 12-in. caliber are practically under contract with the Bethlehem Iron Company. Seventy-three 12-in. sea-coast mortars are under contract or completed.

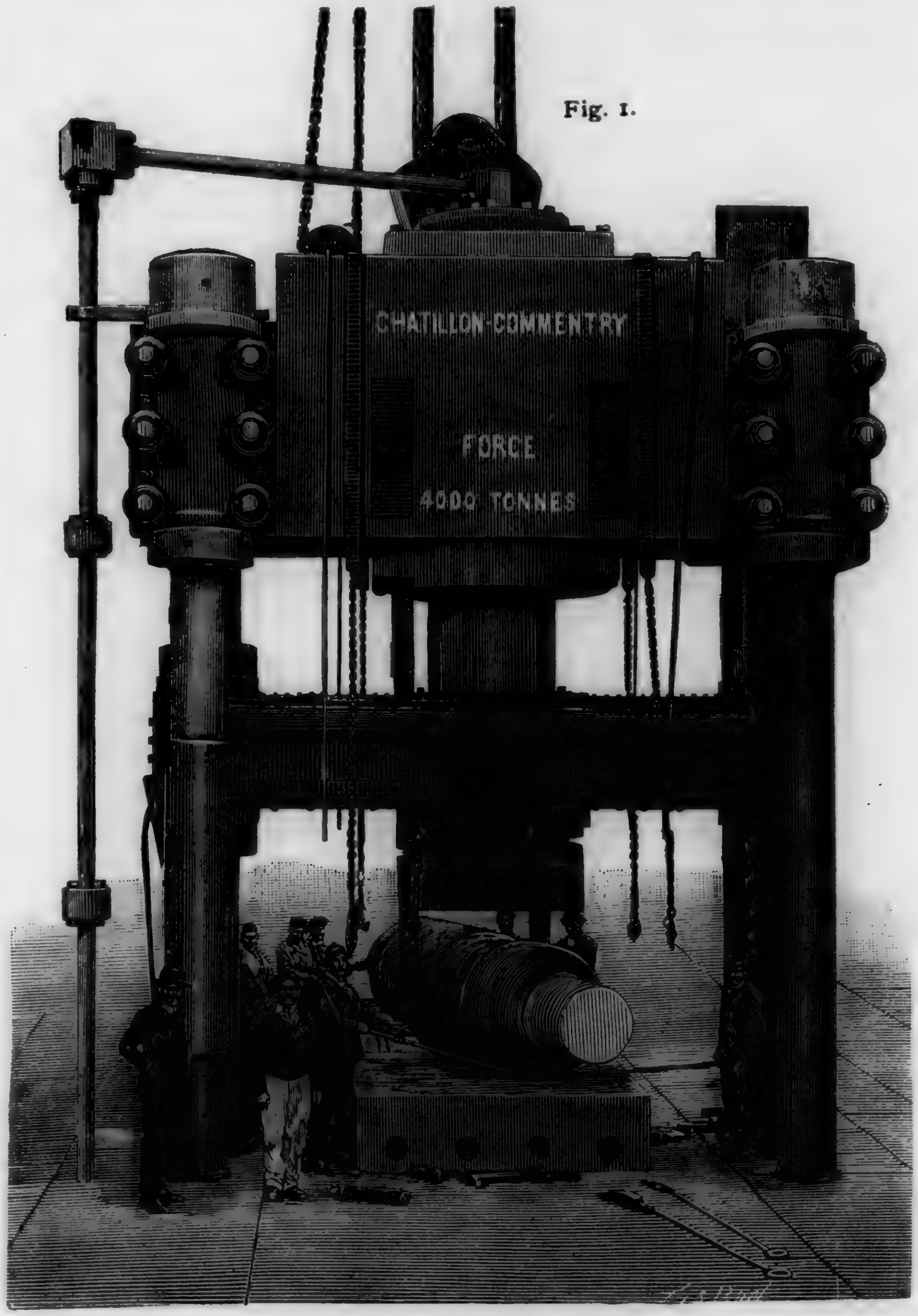
"Types of gun and mortar carriages have been procured and are undergoing tests; considerable success has attended the efforts to produce an American slow-burning prismatic powder that shall render the United States independent of foreign manufacturers; a beginning has been made on the construction of gun and mortar batteries for the protection of our most important ports, while advance has been made along the whole line of defensive preparation. Four years' continuance of similar legislation and activity, and it can no longer be said that the United States is defenseless against foreign powers."

A LARGE HYDRAULIC FORGING PRESS.

ONE of the largest forging presses in existence has recently been erected by the Chatillon-Commentry Company, at its St. Jacques Forge, at Montluçon, France. This machine is intended to make the heaviest forgings, and can exert a pressure of 4 000 tons. The accompanying illustrations, from *le Genie Civil*, show, in fig. 1, a general view of the press; in figs. 2, 3 and 4 a front elevation, side elevation and plan respectively.

The anvil-block has a separate foundation. The upper frame and large hydraulic cylinder are carried by four steel columns, joined at the top by castings and heavy bolts. The ram or die, which corresponds to the hammer-head in a steam hammer, is attached to two steel

Fig. 1.



HYDRAULIC FORGING PRESS.

girders, forming a cross-head. These girders are joined at the end by steel castings, which form guides, working on steel columns placed between the supporting columns, as shown. In these are two hydraulic cylinders, working at a much lower pressure than the main cylinder; their office is to lift the die from the anvil when required. These cylinders are bolted to the cast-iron bed-plate which supports the columns.

The apparatus for the distribution of water, both to the main cylinder and the lifting cylinders, is placed on the left-hand side of the press, and is controlled by two levers, which are placed within easy reach of the hammer-man.

The pumps are driven by a steam engine with two cylinders, which is capable of working up to 500 H.P. The cylinders are 43.3 in. in diameter and 43.3 in. stroke; the valve-gear is the Meyer adjustable cut-off. The cranks on the main shaft are set at right angles. In addition to the cut-off valves, the steam pressure can be closely regulated by the engineer, a lever conveniently placed working a valve in the main steam-pipe.

The high-pressure pump is 5.5 in. in diameter, and the plunger has a stroke of 43.3 in. Ordinarily this pump is run at the rate of 20 strokes per minute when the press is at work.

The accumulator is rectangular in form, and is of heavy steel plates and angles; it is 9 ft. × 12 ft. in size and 16 ft. high, and is loaded to a weight of 180 tons. It is solidly joined to three plungers, each 8.85 in. in diameter and having a stroke of 108.27 in. These pistons work in heavy cylinders of cast steel set in a bed-plate prepared for them. By an arrangement of two valves the water from the pumps can be turned into one of these cylinders alone, into two of them, or into all three at once. In this way the pressure on the main cylinder of the press, and consequently on the ram, can be made 2,075 lbs., 3,110 lbs., or 6,220 lbs. per square inch, as three, two, or one of the accumulator cylinders may be in use.

With such enormous pressures, it will readily be understood that all the connections had to be made very heavy, and the greatest care exercised in packing. The piston of the main cylinder is packed with heavy cup-rings of leather. The walls of the steel cylinders in which the accumulator pistons work are 3.78 in. thick.

To prevent accidents from the too rapid descent of the accumulator, it has a system of counterbalance weights to prevent it from descending too far. It is also furnished with a trip which, should it pass a certain point, acts on a lever which closes the steam valve, at once stopping the engine and the pumps.

The two hydraulic cylinders which lift the ram work at a much lower pressure. The pumps supplying them are driven by a separate engine having two cylinders 12 in. in diameter and 18 in. stroke. These pumps are connected with an accumulator which consists of a steel cylinder 9.84 ft. in diameter and 12.3 ft. long, connected with a plunger 18 in. in diameter and having a stroke of 34.26 ft. Water is forced into the lifting cylinders with a pressure of 710 lbs. per square inch.

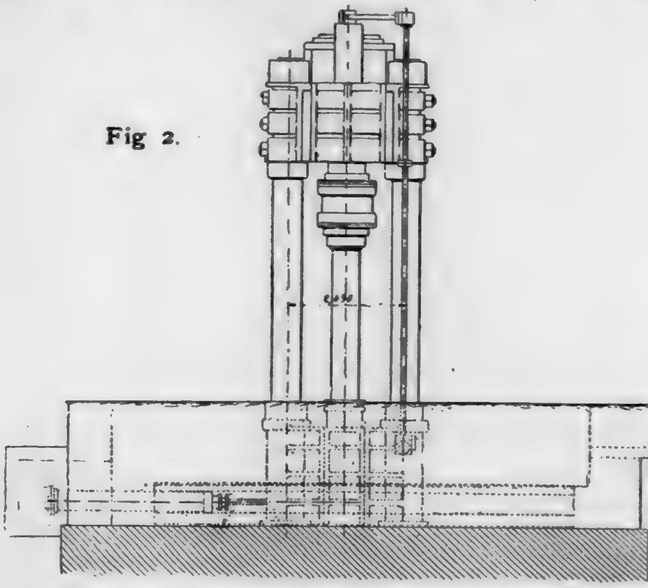
The forging press is placed in a building erected for it; this building is entirely of iron, and 177 ft. long and 72 ft. wide, with a clear height of 50.5 ft. under the roof trusses. The heating furnaces are placed at one side of this building, and are so arranged as to give the most convenient access. At one end of the main building is a wing or annex of the same length, but of somewhat less width and height; in this are placed the engines, pumps, accumulators and boilers.

The press is served by two traveling cranes, one of 40 tons and one of 75 tons capacity. The tracks on which these cranes run are supported by iron columns. The shop is lighted by electric lights. The arrangements are such that the heaviest forgings can be handled without difficulty.

The first work done with this press was the forging of some heavy steel armor-plates of peculiar shape for the new battle-ship *Brennus*. It is to be used for armor-plate, gun-forgings, large shafts and similar work, and for roughing or squeezing down large ingots.

In relation to the use of this and similar presses, reference may be made to M. Chomienne's discussion of the hammer and the press, which was published in the JOURNAL for August, 1889, page 353, in Notes on Steam Hammers.

Fig 2.



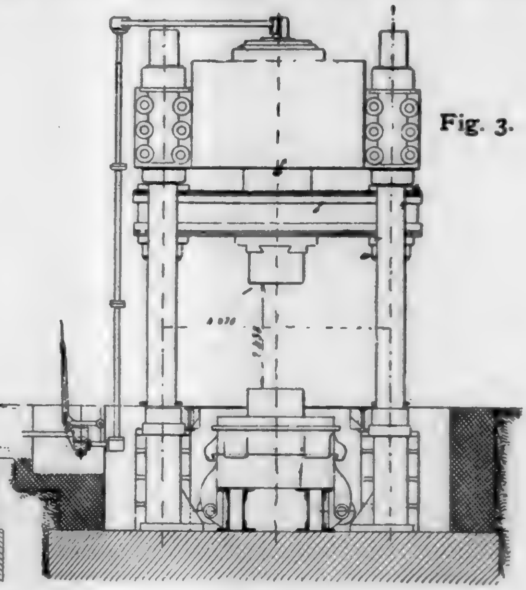


Fig. 3.

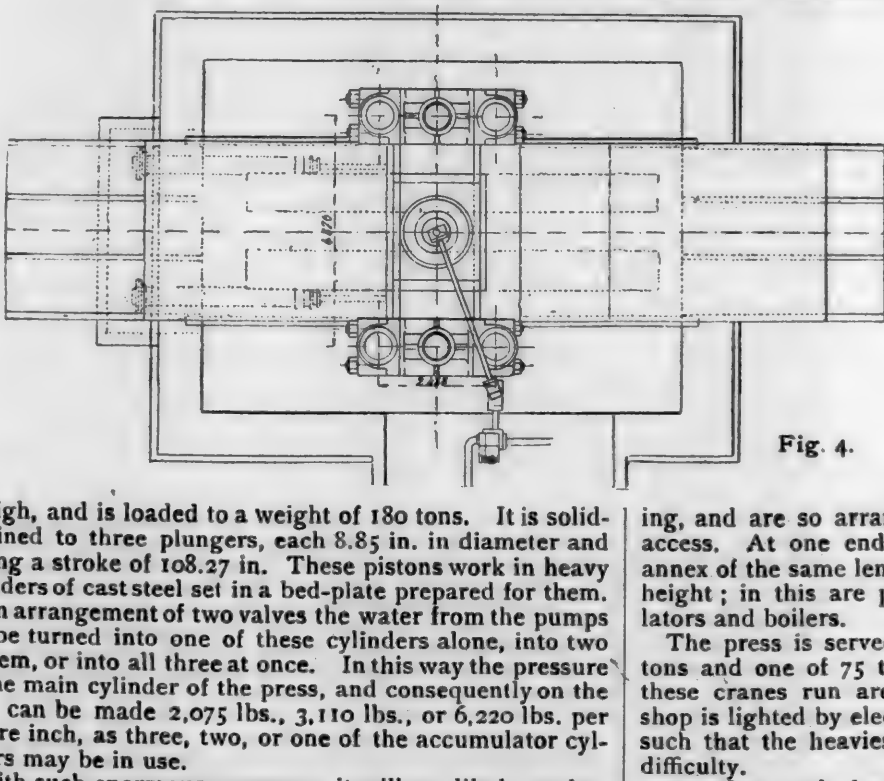


Fig. 4.

HYDRAULIC FORGING PRESS.

A FOUR-CYLINDER COMPOUND LOCOMOTIVE.

IN the paper on compound locomotives by M. Mallet, which was published in the JOURNAL some time ago, reference was made to the four-cylinder double-truck type of engine adopted by the Decauville Works, on some of the French departmental lines and on the Gothard Railroad.

The accompanying illustration, from the *Engineer*, shows an engine of this type, one of several recently built for the Saxon State Railroads by the Chemnitz Engine Works.

This engine, as will be seen from the general view, is carried on eight wheels, all driving-wheels, each set or group of four being placed in a separate truck frame. The two truck frames are connected by an oblique coupling. The boiler and side-tanks are carried on an independent frame, which is connected to the truck frames by center and side bearings.

The two high-pressure cylinders are carried on the rear truck and the two low-pressure cylinders on the front truck. The steam connection between the two groups is shown in section in fig. 2, in which the couplings are shown. This pipe *F* serves as a receiver for the exhaust steam from the high-pressure cylinders, and live steam from the boiler can also be admitted to it when required.

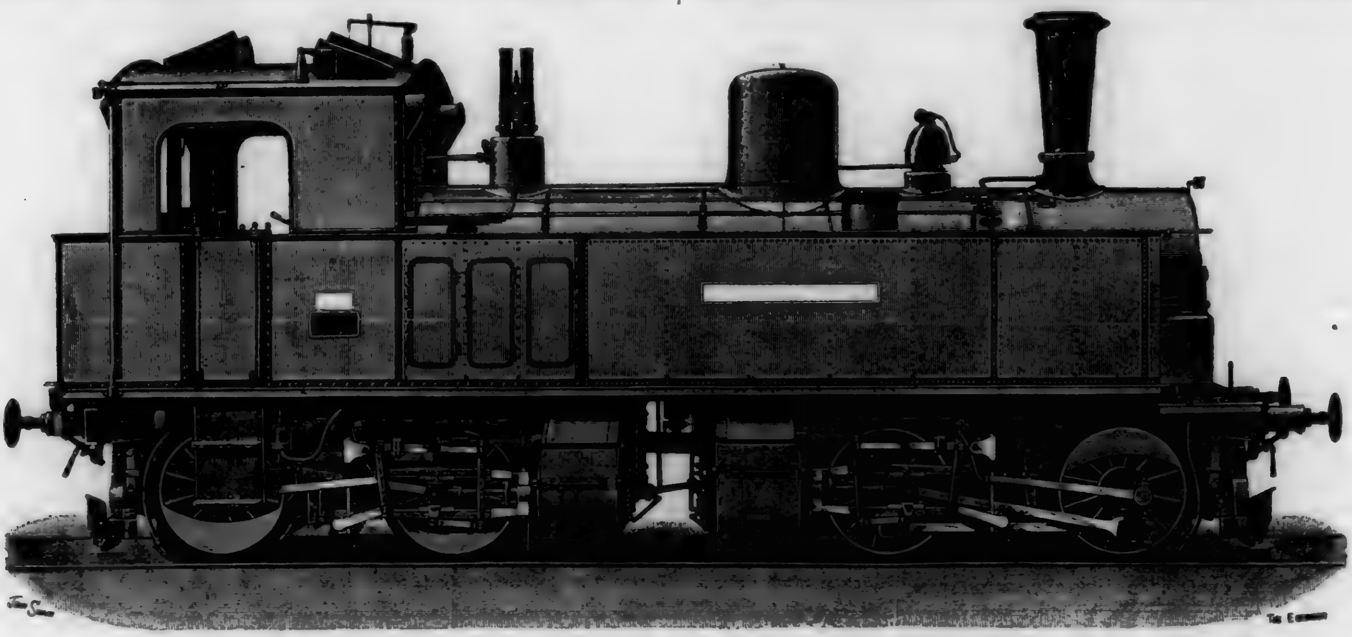
The starting-gear employed is the Lindner system. In this an auxiliary steam-pipe *A* runs from the throttle to the steam-pipe or receiver *F*. When the throttle-valve is opened one-half or more, live steam passes into this pipe *A*, in which a four-way cock is fitted, so connected with the reversing lever that the movement of the latter when placed in full gear, either forward or backward, opens the cock and admits live steam to the receiver *F*, and so to the low-pressure cylinders; this supply is shut off when the reversing lever is in any other position. The point of cut-off when the reversing lever is in full gear is about 70 per cent. of the stroke. No live steam can pass into the receiver except when the reversing lever is at the point named, no matter how far the throttle-valve is opened.

The valve-gear used is the Walschaert gear, and is so arranged that the point of cut-off for the high-pressure and the low-pressure cylinders is the same for any degree of expansion in both forward and backward gear. The ratio between the high and the low-pressure cylinders is 1:2.35. It is claimed that any slipping of the low-pressure driving-wheels will be stopped at once, because while the slipping is going on the steam required for the low-pressure pistons will exceed the amount delivered from the high-pressure cylinders, and the effect on the driving-wheels of the low-pressure truck will decrease. In the same way, if any slip should occur with the high-pressure truck wheels, it will be quickly stopped, because then more steam would be going from the high-pressure cylinders than the low-pressure cylinders could receive, and there would be a rapid increase of back-pressure from the receiver, with a corresponding decrease of the power exerted on the drivers. This equalization of the effort on the two pairs of pistons is claimed as an important advantage.

The boiler of this engine has 14.75 sq. ft. grate area; the total heating surface is 930 sq. ft., of which 58.2 sq. ft. are direct, in the fire-box, and 871.8 sq. ft. in the tubes. The side tanks will hold about 1,200 gallons of water, and the coal-box about 4,000 lbs. of coal. The weight of the engine with tanks and coal-boxes full is 112,400 lbs., the whole weight, of course, resting on the drivers.

The high-pressure cylinders are 11.8 in. in diameter and the low-pressure cylinders 18.1 in., all having 21 in. stroke. The driving-wheels are 43.3 in. in diameter. The usual working pressure is 170 lbs.

These engines, it is stated, have shown themselves capable of starting heavy trains very easily. The heaviest work credited to them is taking a freight train weighing 150 tons (of 2,204 lbs. each) up a grade of 132 ft. to the mile, 3½ miles long, and having several curves of 656 ft. radius, at a speed of 9½ miles an hour.



FOUR-CYLINDER COMPOUND LOCOMOTIVE, SAXON STATE RAILROADS.

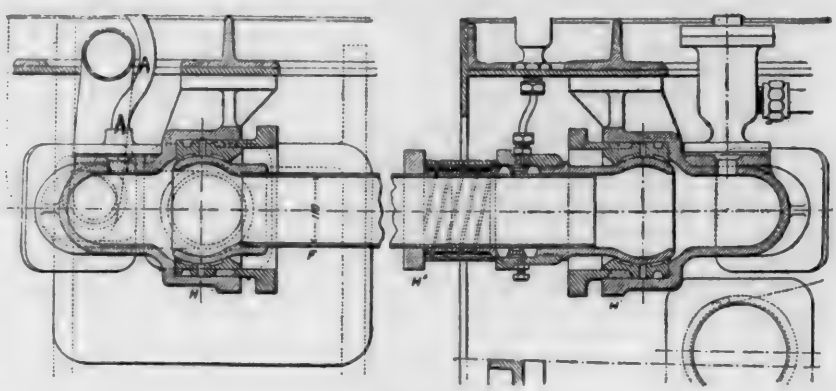


Fig. 2.

Whatever opinion may be held as to the compound feature of these engines, the great objection remains of the complicated system of steam pipes and connections involved in the double-truck form of locomotive. It may be doubted whether the gain claimed for the compound system will counterbalance the increased first cost and expense of maintenance of this type.

The Chemnitz Works are building 10 more engines of the same type for a road of 1 meter gauge; they are lighter engines than the one described above, having cylinders 9.5 in. and 14.6 in. in diameter, 30-in. driving-wheels, and weighing 55,100 lbs. in working order.

NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(*Continued from page* 26.)

LIQUID FUEL.

Heretofore we have only considered solid fuel, and especially coal ; and we can hardly speak by experience of heating with liquid hydrocarbons. Their use, considering the heating effect, is more costly at present than that of coal, and it has only been rarely attempted in France.

Among liquid fuels, petroleum has been used widely in Russia, owing to its low cost and the high price of coal, and to some extent also in the United States.

It has been claimed that its employ will be greatly increased by the success of the processes for making solid petroleum invented by MM. Terrier and Mercier. In this it is obtained in the form of briquettes of a size easy to handle and sufficiently hard to enable them to be loaded and unloaded and to stand transportation well. In this state it will take fire only in contact with the flame ; it burns easily, and its heating effect is about twice as great as that of coal, while the refuse or ash is very small in quantity. Moreover, it will not become liquid again until it is subject to a temperature of 100° C.

There are certain cases in which the use of liquid fuel may be very advantageous, especially where it is sometimes necessary to increase the production of steam quickly, which would be difficult with most boilers, were coal alone used. By combining the use of coal with that of some liquid fuel the latter becomes a useful auxiliary, coming in as a regulator, and permitting on occasion a considerably increased production which can be stopped when desired. In such a case the liquid fuel should be brought to the surface of the fire-box with the air necessary for its combustion, by means of an injector of some form, and so arranged that it will take fire at once as it is distributed from the openings of the apparatus. This injector is fed by steam which passes through it, and on leaving the opening meets an annular current of liquid fuel, mixed with which it passes into the fire-box. Under this action, if the injector is properly arranged, a strong draft of air is created. With proper apparatus of this kind, the quantity of fuel fed may be regulated by the movement of a valve, and in this way we can control absolutely the production of steam. In England an arrangement of this kind has been applied to locomotives using petroleum refuse, and has enabled the engineer to secure a considerable increase in the production of steam when it is needed on heavy grades or in running against a strong head wind.

Petroleum has been studied by M. St. Clair Deville, and some of the results obtained by him are given in the table below :

Kind of Oil.	Density.	Actual Calorific Effect.	Composition of Oil. C.	H.	O.	Calculated Calorific Effect.*
White Oak, W. Va., distilled...	0.819 at 13° C.	10,104	85.3	13.9	0.8	11,626
Burning Spring, W. Va., dist'd..	0.762 at 14.2° C.	10,146	84.0	14.4	1.6	11,681
Oil Creek, Pa., crude...........	0.816 at 0° C.	9,887	82.0	14.8	3.2	11,588
Heavy Oil, Parisian Gas Co., distilled from coal..............	1.044 at 0° C.	8,849	82.0	7.6	10.4	8,797

*This Calorific Power is calculated by the formula $8080\,C + \left(H - \frac{O}{8}\right) \times 34{,}500$.

It will be seen from this : 1. The calorific effect of liquid hydrocarbons increases as the proportion of hydrogen is greater.

2. That the calculated calorific effect differs from the actual result less when the proportion of hydrogen is smaller or the density greater.

If we take a coal developing 7,000 *calorics*, there will be required to replace 1 kg. of mineral oil at 11,000 *calorics :*

$$\frac{11{,}000}{7{,}000} = 1.57 \text{ kg. of coal.}$$

The sum required to obtain the same amount of heat, taking the respective prices at 0.02 franc per kilogramme of coal and 0.30 franc for the same weight of oil, will be :

For coal : 1.57 kg. × 0.02 fr. = 0.0314 fr.
For oil : 1.00 kg. × 0.30 fr. = 0.3000 fr.

That is, the cost of oil will be nearly 10 times that of coal. This last result will, of course, vary widely, as the relative costs of coal and oil vary.

GASEOUS FUEL.

There is a class of apparatus which secures complete consumption of smoke—that is the gas-burner—but it requires in a general way continuous working, and the applications which have so far been made of it have not given satisfactory results in heating boilers.

Gas not having a sensible radiating power, direct heating surface has not the importance which it has with solid fuel, and the result is that the average production per square meter of heating surface is less than with solid fuel. Moreover, when we have coal of fair quality it seems better to burn it directly upon the grate, since the loss due to producing gas from this coal varies from 17 to 25 per cent., depending on whether the tar is saved or not. On the other hand, gas furnaces can work with coal containing 30 per cent. and more of cinders, which can be bought at a very low price, and the use of which on an ordinary grate would be impossible, even with artificial draft.

Anthracite coals also work very well with the gas producer. Lignite, turf or peat, wood and other fuels can also be employed with the gas producer, especially after they have been dried.

If the gas generator is placed too far from the boiler we lose a part of the heat produced in the generator itself—that is, all the radiated heat plus the sensible heat of the gas. This can be avoided if the generator is placed near the boiler, separated from it only by the combustion chamber. By this arrangement we can utilize the sensible heat of the products of distillation, which is considerable, and we obtain from an equal weight a gas richer in combustible elements and having a greater heating power. It is necessary in this case to use forced draft as much as possible, and to use a jet of warm or heated air in the fire-box, which will produce full combustion of the gases, and will give the flame a direction toward the end of the fire-box opposite the door, while at the same time it will preserve the plates against too rapid action of the flame.

The air forced under the grate may be regulated by a valve easily worked by the firemen. It will aid in the decomposition of the fuel while passing over the bed of burning coal, from which the gas is produced.

This air is first transformed into carbonic acid—an incombustible gas—but in passing over the upper layers of coal it gives up one equivalent of carbon, and is transferred into carbonic oxide, which is a combustible gas. Gas obtained from coal of fair quality in the Siemens gas generator, with natural draft and without any injection of water or steam, has a composition varying as follows :

In volume.

CO..........	22 to 28 per cent.	Combustible elements.
$C_2H_4 + H$. ..	9 to 14 " "	
CO_2..........	4 to 6 " "	Inert gases.
Nitrogen	54 to 67 " "	

The heating power of the cubic meter, calculated by Dulong's law, varies between 1,000 and 1,300 *calorics*.

It is necessary that the flame obtained by the injection of heating air into the combustion chamber should be prolonged almost the whole length of the boiler, and this long flame can be obtained only by preserving the parallelism of the veins of gas and air in order that the oxidation—that is, the combustion, may last as long as possible ; but as at the end of this reaction the gas is poor in combustible elements and the air has lost most of its oxygen, while carbonic acid and nitrogen are in large quantity, we must have a great excess of heated air in order to keep up

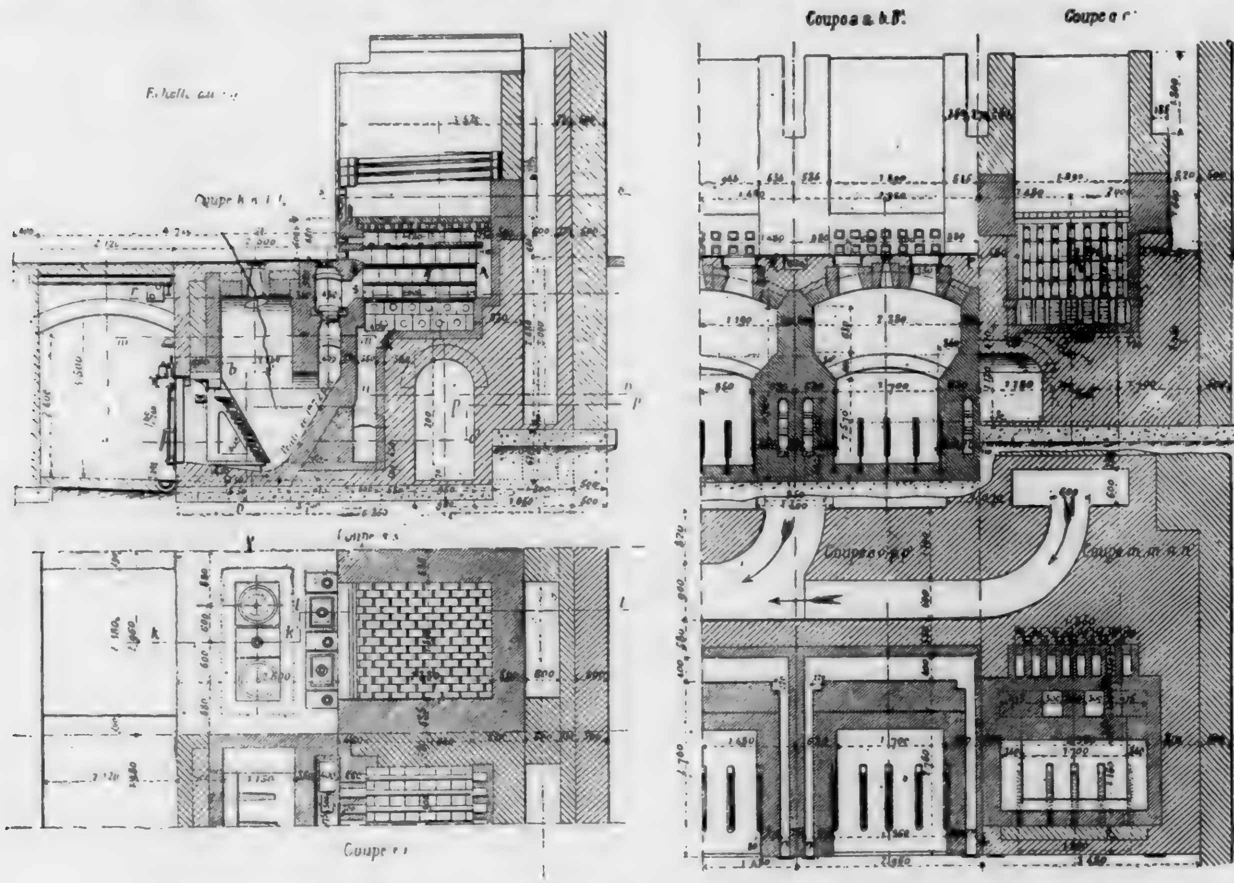
throughout the whole extent of the flame a temperature favorable to the combustion of the remaining traces of combustible elements. For this purpose we require a special form and arrangement of fire-boxes, but this point, I believe, has not been sufficiently considered, and to this neglect is due the poor success obtained in many cases with this apparatus.

We will now describe an application of the gas generator to boilers, with the object of doing away with the ordinary grate, pointing out at the same time the reasons for its adoption and the results. In one of the large factories at St. Denis there are two groups, each composed of four Belleville boilers of 100 H.P. These boilers were formerly fired with Ansin coal, the cost of which was 20 francs per ton. In a day of 11 hours each boiler used 2,600 kgs. of coal, including firing up, and producing 23,000 kgs. of steam at a pressure of 10 kgs., this steam being used only at a pressure of 5 kgs., the pressure being brought down by reducing valves. Each kilogramme of coal produces $\frac{23,000}{2,600} = 8.84$ kgs. of steam, and the cost of 1,000 kgs. of steam was therefore $\frac{2,600 \times 20}{23,000} = 2.26$ francs.

An attempt was made to use gas-coke with the object of replacing the coal. This coke contained 10 per cent. of water and 10 per cent. of cinders, leaving 80 per cent. of combustible matter. It was in large pieces, generally free from dust, and its price was only 17 francs a ton, delivered in the boiler-room. It was found that this coke obliged the firemen to charge and clean their fires about three times as often as with the coal. The heat radiated from the fire injured their eyes, and the lower rows of tubes were burned out in a few months; for these reasons it became evident that the use of this coke on an ordinary grate must be given up.

M. Lencauchez being consulted proposed to replace the ordinary grates in the second group of boilers with gas generators burning this same coke, and he was asked to make the change without altering the boilers. The arrangement which he adopted is shown in the accompanying engraving, which shows the plan and several sections of the boilers and fire-boxes. The results obtained were that 2,000 kgs. of coke produced 15,000 kgs. of steam at a pressure of 10 kgs. Each kilogramme of coke, therefore, produced $\frac{15,000}{2,000} = 7.50$ kgs. of steam, and the cost of 1,000 kgs. of steam was $\frac{2,000 \times 17}{15,000} = 2.26$ francs, or the same as with the coal.

With the new arrangement there was a short flame about 20 in. in height with very complete combustion, and the tubes were not injured. The temperature of the burned gases when they left the tubes and passed into the uptake was 225° Cent. The gas generator could be charged with 25 hectoliters of coke at once, only one charge being made in four hours. A complete cleaning of the grates was required only once in 12 hours, and then took only from 12 to 15 minutes of easy work. The production of steam was also very regular, and the labor required much less, two men being sufficient where four were employed before, while the labor was lighter.



BELLEVILLE BOILER WITH GAS FURNACES.

A regulator of the Belleville type, worked by the pressure of the boiler, maintained a constant pressure of 10 kgs., whether the demand upon the boiler was for 10 or 65 H.P., the production being automatically stopped when the engine stopped. This register opens and closes the draft as the pressure increases or lowers. With this arrangement, also, it was found that a body of fuel kept at a red heat will replace within certain limits, with tubulous boilers, the stored-up steam and water contained in ordinary boilers. This was due in part to the use of the regulator.

The first group of four boilers continued to be run with coal, the gas generator having been applied to the second group only. From the figures given above it was evident that the second group produced steam only in the proportion of 15 : 23, or about 34.8 per cent. less than the other, but the cost of 1,000 kgs. of steam was the same for each group of boilers—that is, without deducting the cost of the alterations, which were considerable. More-

VALUES OF DIFFERENT GASEOUS FUELS.

Kind of Fuel.	Gas obtained from 1 Kg. of Solid Fuel.		Heat Disengaged by Combustion of Gas from 1 Kg.	Heating Power of the Solid Fuel.	Loss due to Gasification.	Relative value of the fuels treated, as compared with gas coal.
	Weight.	Volume at 0° Cent. & 0.76.				
	Kilogrammes.	*Cubic Meters.*	*Calorics.*	*Calorics.*	*Per cent.*	
Coke made in coke ovens	.....	5.000	4,500	7,000	36	0.927
Gas coke	5.325	4.260	4,260	6,400	33	0.878
Anthracite and dry coals	6.330	5.075	5,075	7,500	32	1.046
Coking and gas coals	4.116	3.520	4,850	6,600	27	1.000
Common lignite with 40 per cent. water	1.669	1.460	2,090	3,375	38	0.431
Average peat, with 18 per cent. water	2.110	1.770	2,375	3,250	28	0.490
Wood, with 25 per cent. water	1.930	1.615	2,390	2,900	18	0.493

over, the gas generator permitted the use of a fuel which could easily be procured in large quantities in Paris.

The analysis of the gases as they pass out of the generator give the following results :

CO	21.76
H	10.83
C_2H_4	1.10
C_4H_4	1.38
CO_2	3.57
Nitrogen	61.36
Total	100.00

The heating power of a cubic meter at 0° Cent., and a pressure of 0.76 was found equal to 1,210 calorics. The heat lost in making the gas was 18 per cent., and the cost per cubic meter under the conditions named was 0.008 franc. It is to be observed that the gas generators did not work continuously, but only in the daytime. This was a serious drawback, and with continuous working the results would doubtless have been better.

We ought to say that the use of the gas generator being adopted with certain fuels, calculations should be made for the maximum production of steam, since with coal we can sometimes, without loss and with due regard to economy, drive the boiler a little. This is an advantage in certain cases, but is almost impossible when the gas generator is used.

One drawback to the use of gas generators in heating boilers consists in the great increase of cost and in the necessity of deep foundations, which in some cases cannot be had.

The accompanying table shows the results obtained with the generator using different kinds of fuel :

CONCLUSION.

A careful study of the question of combustion has resulted in the conviction that to secure that economy, which is desirable in order to use properly our store of coal, to prevent it from being exhausted, and to reduce the expenditure in producing steam, we need above all things to properly instruct the firemen upon whom so much depends with any system of boilers and furnaces. It is too often the case, with stationary boilers especially, that this work is entrusted to ignorant men who do not understand the first principles of the work which they are required to do. It has often appeared to the writer that it would be of great benefit to owners of boilers if schools for firemen could be formed where they could receive elementary instruction to fit them for their duties. This would benefit very greatly the workmen themselves, as well as the owners of boilers, and the results would seem to be desirable in every respect. In France this could be done by the district associations of owners of steam boilers ; in other countries other agencies would have to be adopted, according to the local circumstances in each case.

If we except those cases, which really are unusual and only occasionally found, where boilers have been constructed or set up from designs radically wrong, there is one rule that can be universally applied—a good firemen is the best possible coal-saving device.

THE COLUMBIAN EXPOSITION.

THE main building, for the exhibition of Manufactures and the Liberal Arts, which is said to be the largest building of the kind ever planned, is 1,687 ft. long by 787 ft. wide, its greatest dimensions being north and south. It covers an area of 30½ acres. It is rectangular in form, its central hall being surrounded by a nave and two galleries. The feature of the building is the great central hall. It has a clear space of 1,280 × 380 ft. Its roof rises to a height of 245½ ft. at the apex, and the 380 ft. space is covered by a single-arched span, without a supporting column. The height from the floor to the center of the arch is 201 ft. clear, and the height of the lantern above the arch is 44½ ft. Twenty-two steel arches support the center of the roof. Each arch weighs 125 tons, and more than 5,000 tons of steel enter into the construction of the hall. Extending around the hall is a gallery 20 ft. from the floor. It is 67 ft. wide, 21 ft. of this space overhanging the floor of the hall. The total length of this gallery is 3,504 ft. Beyond the gallery, and extending around the central hall, is a nave 108 ft. wide and 114 ft. to the apex of the roof. The east and west halls of this nave are 1,588 ft. long, and the total length of the nave, on the center line, is 4,119 ft. Extending entirely around the nave, and to the outside line of the building, is a gallery 20 ft. from the floor, and 49½ ft. wide. The two galleries are connected with 28 bridges, 50 ft. high and 108 ft. long. There is a fraction less than 11 acres of skylight in the roof, requiring 41 car-loads of glass. There is in the floor and galleries a little more than 41 acres of space. There will enter into the construction of this building more than 1,600 car-loads of material. The building occupies a most conspicuous place in the grounds. It faces the lake, with only lawns and promenades between. North of it is the United States Government building, south the harbor and water basin, and west the Electrical building, and the lagoon separating it from the wooded island. The building will cost $1,500,000.

THE rules governing exhibits in the Department of Transportation, and the classification adopted for that department, have been published in pamphlet form. In this section there will be seven general groups :

Group 80. Railroads, Railroad Plant and Equipment.

Group 81. Street Car and other Short Line Systems.

Group 82. Miscellaneous and Special Railroads.

Group 83. Vehicles and Methods of Transportation on Common Roads.

Group 84. Aerial, Pneumatic and other forms of Transportation.

Group 85. Vessels and Boats—Marine, Lake and River Transportation.

Group 86. Naval Warfare and Coast Defense.

The last-named class—Group 86—will not include our own Navy, whose exhibit will be made in the Government Building.

The main building and annex for the Transportation Department will have over 17 acres of floor space, and will have tracks, transfer-tables, and other facilities.

ENGINES OF AN ENGLISH CRUISER.

(From *Industries*.)

THE accompanying illustrations show the engines of the new cruiser *Naiad* of the English Navy, fig. 1 being a front elevation and fig. 2 an end view. This vessel, with her two sister ships *Latona* and *Melampus*, form partments, and for the better protection of the engine-room an armored breastwork is built round it, which extends from the protective to the upper deck. This breastwork is formed of ¼-in. steel plates, with a teak backing 7 in. thick, this being faced by 5 in. steel armor-plating. The accommodation for the officers is aft, the cabins being sufficiently roomy, and below these is accommodation for petty officers. The full complement for each ship is 252 officers and men.

Placed in two separate stokeholds are five boilers for

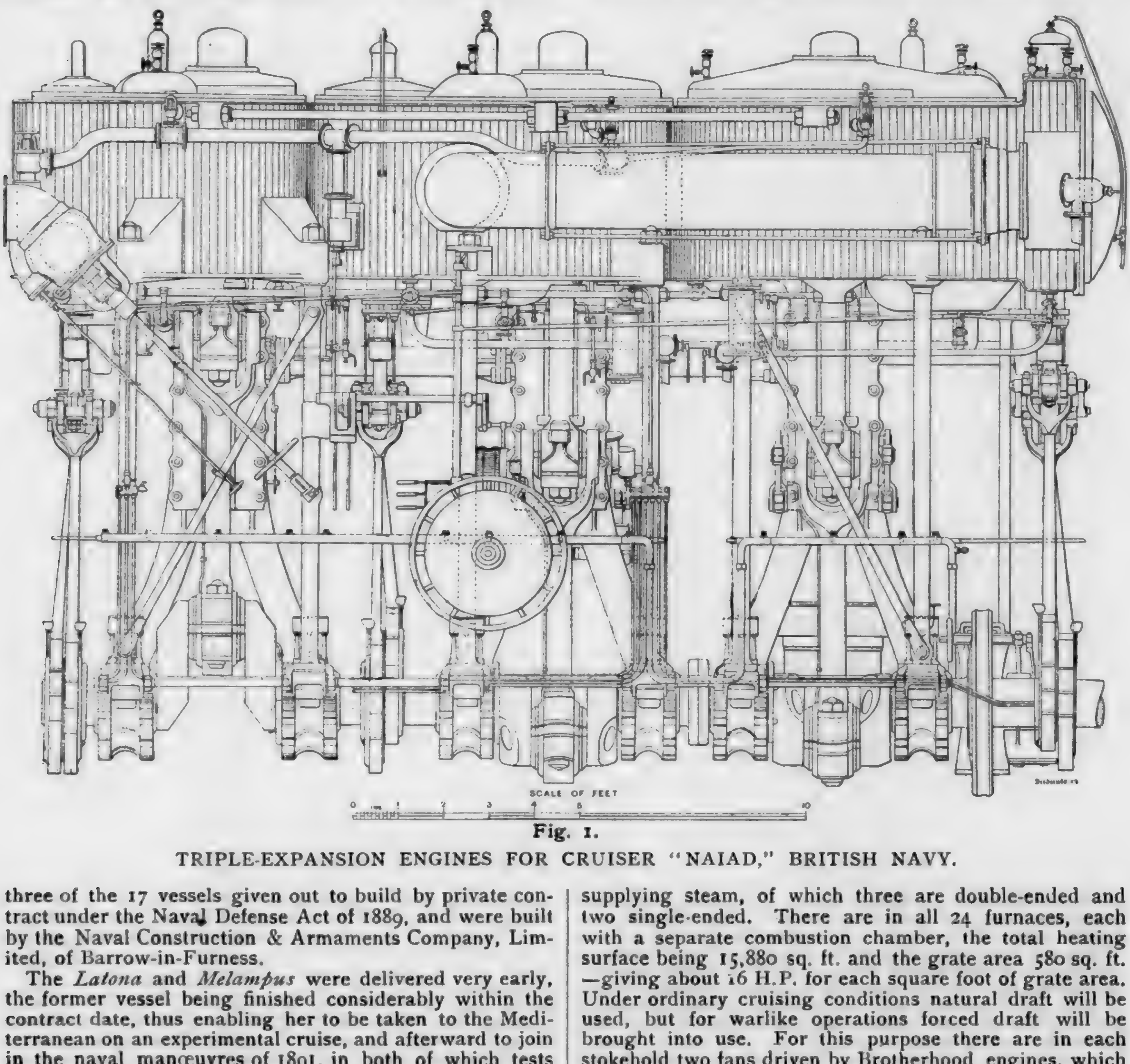


Fig. 1.

TRIPLE-EXPANSION ENGINES FOR CRUISER "NAIAD," BRITISH NAVY.

three of the 17 vessels given out to build by private contract under the Naval Defense Act of 1889, and were built by the Naval Construction & Armaments Company, Limited, of Barrow-in-Furness.

The *Latona* and *Melampus* were delivered very early, the former vessel being finished considerably within the contract date, thus enabling her to be taken to the Mediterranean on an experimental cruise, and afterward to join in the naval manœuvres of 1891, in both of which tests she acquitted herself satisfactorily. The leading dimensions of the *Naiad* are common to the other two vessels, the length being 300 ft.; beam, 43 ft.; and depth to the upper deck, 22 ft. 9 in.; the displacement at the mean draft of 16 ft. 6 in. being 3,400 tons. The stem and stern frames are of cast steel, with apertures to admit torpedo tubes. The vessels are provided with double bottoms, which under the engines and boilers are used as fresh-water feed tanks for supplying the boilers. There are 16 transverse bulkheads extending to the upper deck. The protective deck, formed of 1-in. steel plates on the flat part and 2½-in. steel plating on the slopes, extends throughout the ship to 4 ft. below the water-line, covering the boilers, magazines and torpedo-rooms, and partially enclosing the engine space. The crown of the deck is 1 ft. above the water-line.

The vessel has been divided into 80 water-tight compartments ... supplying steam, of which three are double-ended and two single-ended. There are in all 24 furnaces, each with a separate combustion chamber, the total heating surface being 15,880 sq. ft. and the grate area 580 sq. ft.—giving about 16 H.P. for each square foot of grate area. Under ordinary cruising conditions natural draft will be used, but for warlike operations forced draft will be brought into use. For this purpose there are in each stokehold two fans driven by Brotherhood engines, which can maintain a pressure equal to 3 in. of water. The propellers are of gun-metal, and are 13 ft. diameter, the blades being fitted to allow of variation of pitch. The shafts are of hollow steel, and are carried in steel brackets in the usual manner. There are two compound-wound dynamos, each capable of giving 300 ampères at 80 volts, coupled direct to steam-engines, and on these the entire artificial lighting of the ship depends.

The engines, which are built from designs by Mr. A. Blechynden, are of the type usually adopted in war vessels at the present day, being designed with the object of obtaining the maximum of strength from a given weight of material. They are of the triple-expansion type, with cylinders 33½ in., 49 in., and 74 in. diameter, by 39 in. stroke, and are required by contract to develop 7,000 H.P. with the boilers worked at an air pressure of 0.5 in. of water, and 9,000 H.P. with an air pressure of 1.25 in., the

revolutions at the latter power being 140, and the boiler pressure 155 lbs. per square inch. There are two engines, each driving one screw.

On the trials, which in the cases of all the three ships were carried out at Portsmouth, these powers were exceeded, in all cases everything working in a uniformly satisfactory manner, so that no hitch of any kind in the machinery caused loss or delay in a single trial.

On the eight hours' steam trial with natural draft the engines of the *Naiad* gave the following averages: Steam-

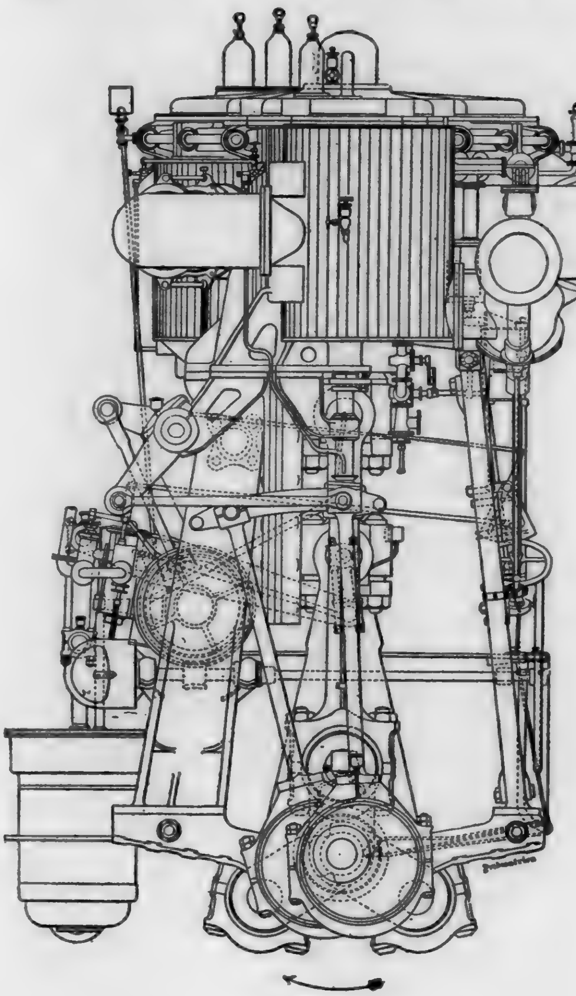


Fig. 2.

pressure, 153 lbs.; revolutions, 136.2; power indicated, 4,251 H.P. On the four hours' trial with forced draft the averages were: 150 lbs. steam; 145.7 revolutions; 9,250 H.P. Over the measured mile the speeds obtained were 19.05 knots with natural draft and 20.2 knots with forced draft.

The armament carried by these cruisers consists of two 6-in. breech-loading rifles; six 4.7-in. rapid-fire guns; eight 6-pdr. rapid-fire guns; one 3-pdr. Hotchkiss and four Nordenfeldt machine guns. There are also four torpedo-tubes.

THE SAULT STE. MARIE CANAL TRAFFIC.

THE comparative statement of the business of the Sault Ste. Marie Canal for the season is as follows:

	1891.	1890.	Change.
Vessels passed through	10,191	10,557	Dec. 366
No. of lockages	4,981	4,970	Inc. 11
No. of passengers	26,190	24,856	Inc. 1,334
Tons of freight	8,888,759	9,041,213	Dec. 152,454

Of the number of vessels 7,339 were steamers, 2,405 sailing vessels and 447 rafts and other unregistered craft.

Iron ore showed a decrease in 1891 of 1,012,280 tons, or 50 per cent., and the decrease was entirely from this cause. The course of business of the season is explained in the following extract from the report of General O. M. Poe, the engineer in charge of the canal:

The canal opened for navigation, April 27, 1891, and closed December 7. The season was, therefore, 225 days long, or three days shorter than in 1890. The average number of vessels passing per day for the whole season was 45.3, and for the months of June, July, August and September, the average was 54.6. The size of the vessels continues to increase, as is shown in the following statistics:

In 1887 the average registered tonnage per vessel was	626.3 tons
" 1888 " " " " " " "	701.5 "
" 1889 " " " " " " "	790.5 "
" 1890 " " " " " " "	833.8 "
" 1891 " " " " " " "	862.1 "

The total registered tonnage for the season falls 53,750 tons short of that for 1890, and the freight tonnage was 152,454 tons less. The following discussion of the appended statistics may not be inappropriate:

For the whole period since 1881, the iron ore carried through the canal has been 47 per cent. of the total freight, and in 1889 and 1890 it was more than 50 per cent.; therefore the freight may be divided into two nearly equal parts, one of which was the iron ore, the remainder being the aggregate of all other freights. The percentage of increase since 1881 falls between 12 and 39 each year, the average being 22. During 1890 the freight, other than iron ore, amounted to 4,266,445 tons, and for 1891, 5,328,548 tons. This shows an increase of 25 per cent. in the freight of 1891—other than iron ore—over 1890; or a little more than the average increase for the preceding ten years. Hence the decrease in iron ore freight alone is sufficient to explain why the business of 1891 did not show the usual increase. There were other causes, however, which materially affected the volume of the season's business, and they will be referred to later. The falling off in iron ore freight was predicted with certainty a year ago. It was due to causes so widespread and long-continued that a discussion here could hardly be made complete and satisfactory.

The freight of wheat and wheat products was abnormally large. Excluding iron ore and wheat in 1890, the remaining tonnage was 3,725,866 tons. The corresponding freight for 1891 was 4,340,660 tons. Hence the increase in freight, exclusive of iron ore, was 8 per cent., which indicates quite a falling off from the average rate of 22 per cent. for the last ten years, and shows that if the wheat crop of the northwest had not been unusually good this season there would have been a slight decrease in the volume of freight other than iron ore.

A further reason is found in the fact that the average stage of water in the lakes was lower than for many years past, so that the larger vessels were unable to take full cargoes. The traffic of the season was also light at the beginning, many ship-owners holding their vessels back in the hope of improving rates. The falling off in the iron ore traffic, however, remains the principal event of the season.

All things considered, the large amount of business actually done is a remarkable fact, and shows the great and increasing importance of the lake route in the transportation system of the country.

THE UNITED STATES NAVY.

SOME comparisons have been made between the new cruiser *New York* and the English cruiser *Blake*, which is a vessel of very much the same class. The *Blake* has some 900 tons more displacement than the *New York*, but her armament differs considerably from that of the American cruiser. The main battery consists of two 9.2-in. guns and ten 6-in. rapid-fire guns; the secondary battery includes sixteen 3-pdr. rapid-fire and seven machine guns, and she has four 14-in. torpedo tubes. The *New York* will have six 8-in. guns and twelve 4-in. rapid-fire guns in her main battery; eight 6-pdr. and four 1-pdr. rapid-fire and four machine guns in the secondary battery and six 18-in. torpedo-tubes.

The total weight of the *Blake's* fire is 1,808 lbs.; the total weight of her broadside fire 1,284 lbs., and of her fire ahead or astern 604 lbs. The *New York* will be able

to discharge 1,948 lbs. at a single round, of which 1,474 lbs. can be concentrated on a broadside fire and 1,156 lbs. ahead or astern, thus giving her a considerable advantage in weight of metal. The 9.2-in. guns of the *Blake* carry a projectile of 380 lbs., while the 8-in. shot weighs only 250 lbs.; but the higher velocity obtained from the American guns will give the shot almost equal penetration, and the that they are of sufficient strength to carry batteries of heavy rapid-fire guns, and are otherwise adapted for cruising. Both vessels made the same speed on their trial trips —14.8 knots an hour. Both are iron screw steamers; the *Venezuela* was built at the Cramp yards in Philadelphia, and has triple-expansion engines. The *Newport* was built at the Roach yards at Chester, Pa., and is 306 ft.

THE CERVEYRETTE BRIDGE, HAUTES-ALPES, FRANCE.

8-in. gun has the advantage in ease of handling and quickness of fire. The English 9.2-in. gun has not heretofore secured the best record for accuracy, and the 8-in. guns promise much better results. If the *New York* attains the promised speed she will be well able to stand a comparison with the English cruiser.

THE monitor *Miantonomoh* has been testing her new guns in the vicinity of Gardner's Island, at the eastern end of Long Island Sound. A number of charges have been fired from these guns with full charges and with lighter charges, and the results have been very satisfactory. The working of the turrets is also stated to have been excellent.

THE first of the 12-in. guns for the coast-defense ship *Monterey* has been sent to San Francisco. The gun was shipped by rail, mounted on a car built especially for the purpose and owned by the Pennsylvania Railroad Company. This car has an iron frame, and is carried on 16 wheels, arranged in four four-wheeled trucks.

The second 12-in. gun and the two 10-in. guns for the *Monterey* will follow as soon as possible, and all will be in San Francisco by the time the ship is ready for them. These first large caliber guns were made at the Washington gun-shop, the forgings having been bought in England. Since the first lot, however, all the forgings have been made in this country.

THE steamers *Venezuela*, of the Red D Line, and the *Newport*, of the Pacific Mail Line, have been inspected under the new law to ascertain their speed and other qualifications for postal service, and also to serve as cruisers in time of war. It is understood that both vessels were approved in the latter capacity, the inspectors reporting

long, 38 ft. 2 in. beam and 23 ft. 9 in. depth of hold. She has compound engines, with cylinders 48 in. and 90 in. in diameter and 54 in. stroke. She can carry coal enough for 15 days' continuous cruising at full speed.

THE CERVEYRETTE BRIDGE.

THE accompanying illustrations, from *Le Génie Civil*, show a bridge recently built over the gorge of the Cerveyrette, in the department of Hautes-Alpes, France. It is on a mountain road built for military purposes to connect two frontier forts, Fort des Tetes and Fort Bayard. The ravine at the point of crossing is about 250 ft. wide and 280 ft. deep. The peculiar form of the gorge, as shown in fig. 2, however, permitted the use of an arch of less than 250 ft. span.

In the illustrations fig. 1 is a general view of the bridge; fig. 2 is an elevation, and fig. 3 shows the arrangement of false-work adopted in erecting the bridge.

The conditions required were that the bridge should have a total width of 13.12 ft., including a roadway of 8.20 ft., and two sidewalks of 2.46 ft. each; that the roadway should be macadamized, and that the structure should be proportioned for a rolling load of 62 lbs. per square foot, or of a train of loaded wagons weighing six tons per axle.

The plan adopted has an arch of parabolic form, having a span of 172.2 ft. and a rise of 37.7 ft. The arch is composed of two riveted trusses resting on masonry abutments on either side; these trusses are 6.5 ft. deep at the abutments and 2.5 ft. at the center. The trusses are inclined toward each other, being 19.68 ft. apart at the abutments and 11.81 ft. at the crown of the arch. The roadway is supported by vertical struts which are carried on the arch; a few of them on either side are beyond the arch and rest

on foundations made in the rock. These uprights are spaced 12.3 ft. apart. The trusses of the arch are thoroughly braced by a system of cross-bracing. They rest at the ends on cast-iron shoes secured to the masonry. The total weight of the bridge is 264,480 lbs.

Very little masonry was required, as the rocky sides of

Fig. 2.

the gorge furnished foundations everywhere, only requiring work enough to make level beds for the abutments and supports.

In erecting the bridge advantage was taken of the peculiar section of the gorge to erect scaffolding, as shown

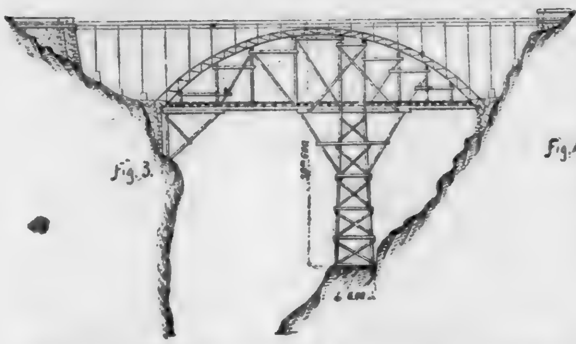


Fig. 3.

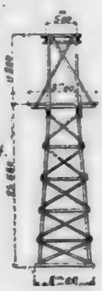


Fig. 4.

in fig. 3. This served to support a timber false-work or temporary bridge thrown across the ravine, which was kept in place until the arch was completed.

The design of the bridge was made by M. Comm. Baldy; it was built by Patiaud & Lagarde, of Lyons, as contractors.

A RAILROAD SCHOOL.

A RAILROAD department has been added to the Swiss Technical School at Bienne, its maintenance being provided for jointly by the Ministry of Railroads of the Swiss Government and the Jura-Simplon Railroad Company. Other companies, it is expected, will join in later. The school is divided into two branches, and its object is to train young men for railroad service. The first branch will prepare those who expect to work as trainmen, station employés, section foremen, and in other simpler grades, while the second is for those who aspire to the higher positions as chief of more important stations—master mechanics and other officers in the general management—and the courses are arranged so as to give the lower instruction or more extended course. Those who desire to prepare themselves for positions in the mechanical department are required to serve an apprenticeship in some well-known machine shop or as fireman on a locomotive. Provision is made by which employés already engaged on a railroad can take a short course of one or two terms. The second term of this school began in August of the present year with 42 pupils, and in addition arrangements had been made by which a number of employés were to take the short course during the winter. In addition to all the facilities of the technical school, the teachers and pupils will be enabled to use the extensive repair shops of the Jura-Simplon Company at Bienne and of the Jura-Berne-Lucerne Company at Yverdon.

CLASSIFICATION OF PIECE-WORK ON LOCOMOTIVES.

(*Continued from page 25.*)

WE continue below the classification of locomotive piece-work, which was begun in the January number. As then explained, this classification is that which has been adopted for the shops of a leading railroad, in which new construction as well as repair work is done, and is for an eight-wheel passenger locomotive. In use it is made out in table form, the columns of the table containing the name of the piece and the work and the price paid, per piece, pair, or set. It has not been thought necessary to use this form here, the object being to show the division and classification of the work only:

DRIVING SPRING AND RIGGING.

Forging Equalizer Stand.
" " Beam.
" Front Spring Hanger.
" Back " "
" Intermediate Spring Hanger.
" Spring Plate.
" Large Spring Keys.
" Small " "
" Spring Hanger Bolt.
Drawing Spring Plate.
Forging Band.
Setting Plate.
Banding Spring.

Drilling Equalizer Stand.
Planing " "
Slotting "
Milling "
Drilling Spring Hanger.
Chipping " "
Planing " Key.
Turning " Hanger Bolt.

DRIVING WHEELS AND AXLES.

Forging Steel Axles.
" " Crank Pins.
" Crank Pin Washer.
" Hexagon Nuts, for Crank Pin.
" Crank Pin Nut.
" Steel Key.

Molding Wheel Center.
" Driving Box.
" " " Oil Cellar.
" Axle Collar.

Planing Driving Box.
Boring " "
Drilling " "
Slotting " "
Fitting " "
Boring Axle Collar.
Turning " "
" Steel Axle.
Milling " "
Turning Crank Pin.
Milling " "
Turning " " Washer.
" " " Nut.
Boring Wheel Center.
Turning " "
Quartering " "

Boring for Crank Pin.
Pressing Wheel Center on Axle.
Boring Steel Tire.
Turning " "
Balancing Wheel Center.
Driving on Tire.
Putting Driving Wheels under Engine.

STEEL MAIN RODS.

Blocking Main and Side Rods (at furnace).
Trimming " " " " (at forge).
Forging " Rod Strap.
" Side " "
" Safety Yoke.
" Main Rod Keys.
" " " Gibbs.

Molding " " Brasses.
" Side " Bushings.
" Rod Oil Cup.

Planing Main Rod Brasses.
Boring " " "
Turning Side " Bushings.
" Rod Oil Cups.
Planing Main Rods.
Milling Keyways.
Facing Rods.
Planing Main Strap.
Slotting " "
Boring Brasses.
Grinding and Buffing.
Turning Steel Set Screws.
" Main Rod Strap Bolt.
Tapping " " " " Nuts.
Turning Oil Cup.
" " Cellar Bolt.
Fitting up Oil Cellar.
" " Rods.
Filing Brasses and Putting on Engine.

STEEL SIDE RODS.

Planing Side Rods.
Milling " "
Boring " "
Turning and Boring Bushing.
" Oil Cup Bolt.
Fitting up Rods.
Filing Brasses and Putting on Engine.

BOILER CASTINGS.

Molding Extension Side Step.
" " Hand Hold Plates.
" " " " Caps.
" " Spark Drop.
" " " Slide.
" Name Plate.
" Furnace Door Frame.
" " " R. & L.
" " " Slide.
" " " Thimble.
" Hand Rail Column, Middle.
" " " " End.
" " " " Side.
" " " Ornament.
" " " Socket.
" Grate Bearing Bar.
" Drop Grate.
" Dead "
" Grate Bars.
" Bearings for Ash Pan Slide.

BOILER FORGINGS.

Forging Mud Ring.
" Smoke Box Ring.
" Connecting Ring.
" Extension Ring.
" Jaws for Braces.
" Male Ends for Braces.
" Crown Bars.
" Reinforcement Ring.
" Steam Joint Ring.

Forging Flue Head Braces.
" Rib Braces.
" Flat Ends for Braces.
" Links for Crown Bars.
" Door Bar.
Crown Bar Bolts.
" Crank.
" Flues.
" ⅞-in. Pins.
" ¾-in. Pins.
" 1-in. Pins.
" Diaphragm Braces.
" Bearing Bar Lug.
Forging Grate Rigging.
" Ash Pan Rigging.

Drilling Extension Step.
Turning Hand Hold Plate.
" " " Cap.
Boring Spark Drop.
Slotting " "
Drilling " "
Planing " Slide.
Drilling Name Plate.
Planing Furnace Door Frame.
Drilling " " "
Planing " "
" " " Slide.
Turning " " Thimble.
Drilling Hand Hold Column, Middle.
Tapping " " " "
Drilling " " " End.
Tapping " " " "
Drilling " " " Side.
Tapping " " " "
Turning " " Ornament.
Boring " " Socket.
Turning Bearing Bar Lug.
Planing Mud Ring.
Drilling " "
Turning Smoke Box Ring.
Drilling " " "
Turning Connecting Ring.
Drilling " "
Turning Extension Ring.
Drilling " "
" Brace Jaws.
" Male End Braces.
" Crown Bars.
" Reinforcement Ring.
" Steam Joint Ring.
" Flue Head Braces.
" Rib Braces.
" Flat Ends for Braces.
" Links for Crown Bars.
" Door Bar.
" Crown Bar Bolts.
" Crank.
" Diaphragm Braces.
" Grate Rigging.
" Ash Pan Rigging.

[ENGINE BOILER.

Laying off Boiler.]
Flanging "
Drilling "
Punching "
Planing "
Bracing "
Fitting up "
Steam Riveting Boiler.
Hand " "
Caulking "
Blacksmithing "
Putting in Stay Bolts.
Driving " "
Making Boiler Bracket.
Drilling Flue Holes.
Putting in Flues.
" " Fire Brick.
" " Combustible Tubes.

Fitting and Putting in Grate and Bearing Bars.
" " " up Arch over Axle.
Making Apron.
" Foot-board Plates.
Building Ash-pan.
Applying " "
Testing Boiler.
Making Spark-drop.
" and Putting in Diaphragm and Netting.
Building and Putting on Smoke Stack.
" Air-tank.
Lagging Boiler.
Casing "

BOILER FITTINGS.

Fitting on Extension Step.
" in Spark Casting.
" Initial Plate on Boiler.
" Smoke-stack Base on Boiler.
" up Short Hand-railing.
" " Long " "
" Mud-plug in Boiler.
" Blow-off Cock in Boiler.
" up Furnace Door Frame.

PILOT.

Forging Pilot Braces.
" " Band.
" " Draw-head.
" " Heel-brace.
Molding Steps.
" Nose Casting.
Making Pilot.
Putting on Pilot Band.
" Pilot on Engine.

BUMPER.

Forging Bumper Braces.
Molding Bumper Knee.
" Flag Stand.
Planing Bumper Knee.
Drilling " "
Making Bumper.
Putting " on Engine.
Making " Deck Plate.
" " Step Braces.

FRONT.

Molding Smoke-box Front.
" " " Door.
" " " Knob.
" Number Plate.
" Head-lamp Bracket.
" " " Column.
Turning Smoke-box Front.
" " " Door.
Drilling Hinges on Front and Door.
Fitting Door in Front.
" up Front and Door.
" " Lamp Bracket.
" " Number Plate.
" " Hand Railing.
" " Signal Lamp Bracket.

STEAM-PIPES.

Molding Steam-pipes, Right and Left.
" Cross-pipe.
" Exhaust Base.
" " Nozzle.
" Steam-pipe Joint.
Slotting Steam-pipes.
Facing off Cross-pipe.
Drilling and Balling Steam-pipe.
Turning Steam-pipe Joint.
Grinding " " "
Fitting up Steam-pipes.

THROTTLE AND DRY-PIPE.

Molding Upright Pipe.
" Throttle Chamber.
" " Valve.
" Stuffing-box.
" Elbow for Dry-pipe.
" Sleeve " " "
Turning Throttle Upright Pipe.
" Dry-pipe End, Large.
" " " " Small.
" Throttle Lever End.
" " Stuffing-box.
" " " " Stem.
Boring " Chamber Pipe.
Riveting Dry-pipe Casting.
Fitting up Throttle and Dry-pipe.

MANIFOLD.

Molding Manifold.
Turning "
Drilling "
Fitting "
" " in Boiler.

SAND-BOX.

Molding Sand-box Base.
" " " Casing Cover.
" " " Lid.
" " " Valve.
" " " " Crank.
" " " Link.
Turning " " Base.
" " " Casing Cover.
" " " Lid.
Filing " Rod Handles.
Fitting up Sand-box, Complete.

BELL.

Forging Bell Hanger.
" " Clapper.
Molding Bell.
" " Stand.
" " Yoke.
" " Rope Crank.
Turning Bell.
" " Clapper.
" " Yoke.
Boring " "
Slotting " Stand.
Boring " "
Drilling " "
Fitting up " and Bell.

DOME.

Molding Dome Ring.
" " Casing Base.
" " " Cover.
" " Cap.
Turning " "
" " Ring.
" " Casing Base.
" " " Cover.
Drilling " Cap.
Making and Putting on Joint.
Fitting up Dome Base, Cover and Cap.

SAFETY-VALVE.

Forging Safety-valve Lever.
" " " Fulcrum.
" " " Stand.
Molding " "
Turning " "
Grinding " " Joint.
Fitting up Safety-valve.

POP-VALVE.

Molding Pop-valve.
" " Bridge.
Forging Pop-valve, Stem.
Turning " "
" " " Stem.
" " " Seat.
Fitting up Pop-valve.

WHISTLE.

Forging Whistle Lever.
" " Plug.
Molding Whistle.
" " Handle.
" " Shaft Stand.
" " " Crank.
" " Bell "

Turning Whistle.
" " Plug.
" " Shaft.
Fitting up Whistle.

RUNNING BOARDS.

Forging Running Board Brace.
Dressing " "
Sizing " "
Making " "
" " " Strip, or Strap.
Putting on Running Board " " "
Drilling Running Board Braces.
Fitting " " "
Putting " " on Engine.

CAB.

Forging Cab Brace.
Molding " Bracket, Right and Left.
" " Saddle.
" " Gong.
Dressing Cab.
Cutting and Sizing Cab.
Tenoning Cab.
Mortising "
Boring "
Working Moldings.
Band Sawing Cab.
Fitting up "
Making Cab Plates.
Drilling and Fitting Cab Bracket.
" " " Front Cab Bracket.
Fitting Cab Gong.
" " Door Hooks.
Bronzing Cab Door Hooks.
Fitting " " Bolts.
" " " Long Slide Hooks.
" " " Lifts.
Fitting Cab Bell Cord Ring Pulley.
" " " " Hook.
" " " " Bushing.
Covering Cab Roof with Galvanized Iron.
Fitting " on Boiler.

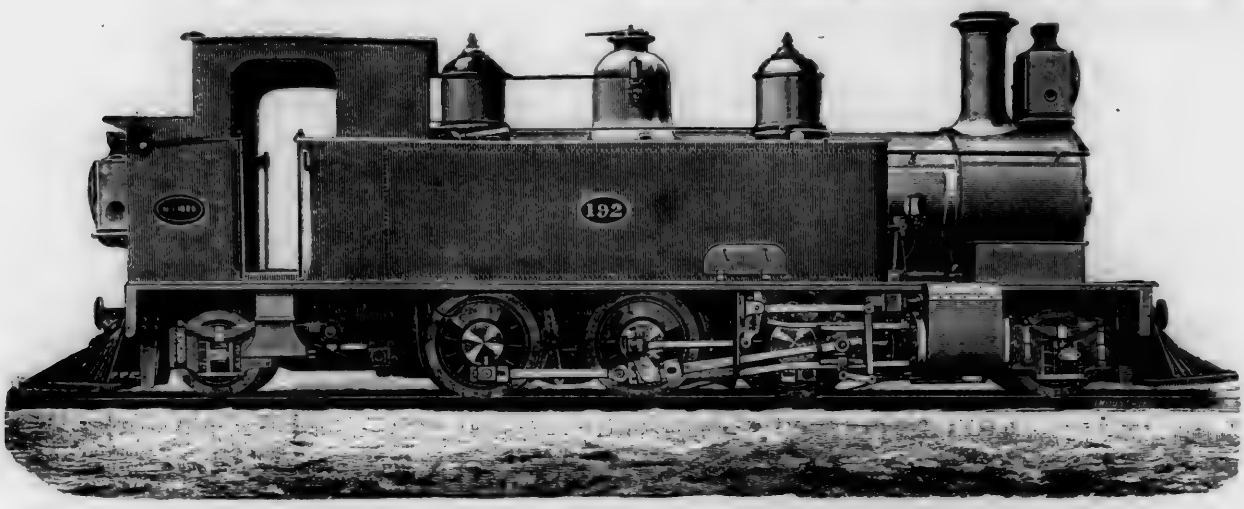
This classification will be concluded in the next number.

(TO BE CONTINUED.)

NEW ZEALAND ROLLING STOCK.

(From *Industries.*)

THE accompanying engravings represent a ten-wheeled tank locomotive and a first-class saloon car constructed for the New Zealand Government Railroads. The engine shown was constructed at the railroad workshops, Christchurch, New Zealand, from designs made by Mr. T. F. Rotherham, the Locomotive Superintendent, to whom we are indebted for photographs and the particulars we now publish. The engine was designed for the heavy gradient traffic on the Wellington system, and is of a type not hitherto used in the colony. The leading particulars are: Gauge, 3 ft. 6 in.; weight, with tanks and bunkers full, 36 tons, distributed as follows: 5¼ tons on each leading and trailing truck axle and 8½ tons on each coupled axle. The boiler is of the Belpaire pattern, 3 ft. 6 in. diameter, of Lowmoor iron $\frac{7}{16}$ in. thick, and capable of allowing a working pressure of 160 lbs. per square inch. The engine has outside cylinders, 14 in. diameter and 20 in. stroke, fitted with Walschaert valve-gear. Owing to the heavy gradients on various sections of the Wellington system, the engine has six wheels coupled, and to easily get round the sharp curves a truck has been provided at each end. We may mention that it has already been running for upward of 18 months on gradients of 1 in 33 with curves of five chains radius, and with a working load, exclusive of its own weight, of 125 tons.



LOCOMOTIVE FOR NEW ZEALAND GOVERNMENT RAILROADS.

The saloon car illustrated has been designed by Mr. T. F. Rotherham, and the design is based on an idea furnished by Mr. J. P. Maxwell, one of the Railroad Commissioners, to meet the requirements of the service and to render long journeys less irksome. These cars are 39 ft. 6 in. long, carried on two four-wheeled trucks, the centers of which are 26 ft. 6 in. apart; the trucks have wheel-bases of 4 ft. 10 in. The cars are divided into four compartments, one general, two small first-class, and one fitted with lavatory, etc., while along one side, for rather more than half the length of the body, a gallery extends, formed by the difference in width between the general and smaller apartments. This gallery, which is accessible from all apartments, is fenced as shown, for the safety of the passengers, by an ornamental iron railing. The general compartment is intended to carry 20 persons, and the small compartments, one of which is intended for smokers, are each capable of accommodating eight pas-

sengers. The cars are painted Indian red, picked out with black, and fine-lined with yellow, and each weigh 12 tons.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page* 31.)

IT will be seen from the foregoing statements of what has been accomplished with beating wings, that the principal questions are those of motive power and of proportion of surfaces to weight, and the reader will probably first inquire as to what is really the power developed by birds in their flight. The answer must unfortunately be, that it is not accurately known. A great many computations have been made, based upon more or less plausible assumptions, but none of these computations can be absolutely accepted as correctly based upon indisputably measured data.

This ceases to be surprising when we consider that there is no creature so willful, so swift, and so easily affrighted as the bird, and that once in the air, he will not lend himself to be measured experimentally. Mathematicians have, therefore, partly resorted to conjectures for their data. Thus Napier assumed that a swallow weighing 0.58 oz. must beat his wings 2,100 times per minute while going $33\frac{1}{3}$ miles per hour, in order to progress and sustain his weight, and that it therefore expended $\frac{1}{13}$ of a horse power. In point of fact, the bird only beats about 360 times a minute, and is chiefly sustained by the vertical component of the air pressure on the under side of the wings and body, due to the speed, instead of by the direct blow of the wings downward, as supposed in the orthogonal theory already alluded to.

Other mathematicians, starting from the fact that a weight falls about 16 ft. during the first second, and in so dropping does work, have assumed that a b rd in horizontal flight, being then sustained, performs a certain fraction of this work. It is evident, however, that if the bird does not drop, the fraction assumed is purely arbitrary, and that such calculations must be quite worthless.

Experiments to measure directly the power expended have proved failures, and resort has been had to indirect measurements.

Thus Dr. W. Smyth, of Edinburgh, succeeded in measuring with a dynamometer the strain exerted by a 12-oz. pigeon while flexing its wings, when excited by a current of electricity, and found it capable of raising 120 lbs. one foot high in a minute, or at the rate of 160 foot-pounds per pound of bird. Professor Marey performed the same experiment on the buzzard and on the pigeon, and ascertained the contractile strength of their muscles to be 18.46 and 19.91 lbs. to the square inch respectively ;* but as he was unable to measure satisfactorily the rapidity with which the muscles contracted, he did not calculate the foot-pounds.

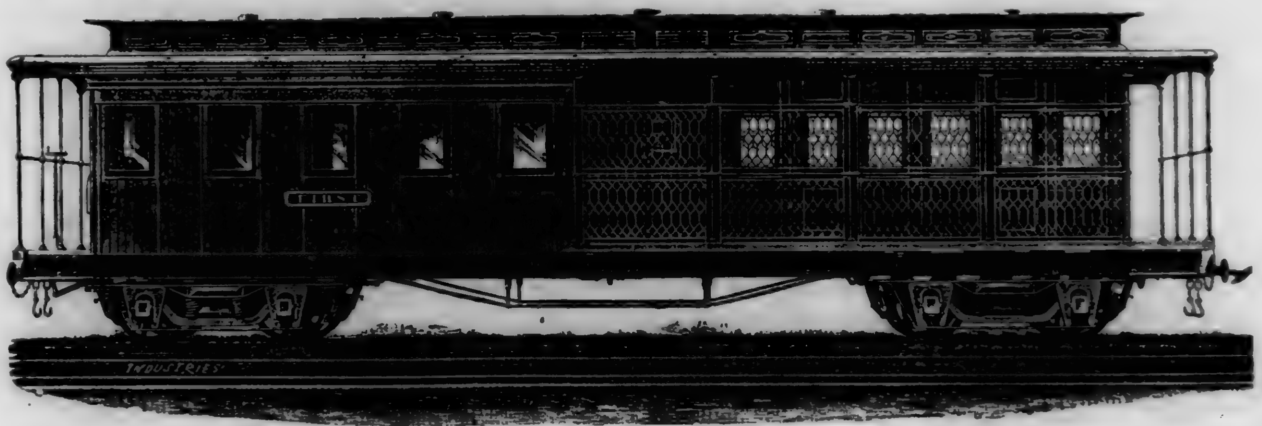
Mr. Alexander, starting with the assumption that a 2-lb. pigeon makes 180 completed strokes per minute, each stroke with an amplitude of 1.5 ft. at the center of pressure, calculates the power exerted as being $2 \times 180 \times 1.5 = 540$ foot-pounds per minute, or at the rate of 270 foot-pounds per pound of bird. This is plausible ; but the most satisfactory computations are those made by Pénaud from observations of the direct velocity of ascent of various birds. From these he concludes that the pigeon, for instance, expends for rising 579 foot-pounds per minute, and that the proportion of horse power to weight is as follows :

For the peacock,	one horse power for every	66 lbs.
" " pigeon,	" " " " "	57 "
" " sparrow,	" " " " "	$48\frac{1}{2}$ "
" " sea pie,	" " " " "	26 "

This, however, is merely the work of elevation, such as would be performed upon a solid support, in addition to which the bird has to overcome the resistance of the air to his motion, and to derive support from this mobile fluid. Pénaud calculates that this additional work amounts to over 1,000 foot-pounds per minute, so that the total work done by the pigeon in rising to a perch 35 ft. above the ground amounts to 1,650 foot-pounds per minute, or 1 horse power for every 20 lbs. Moreover, it must be remembered that the pectoral muscles of birds, which constitute their motor, comprise but one-quarter to one-sixth of their total weight, so that in this particular case the relative weight of the motor is only about 5 lbs. per horse power for the force exerted in rising.

These are formidable figures, but they cease to be discouraging when we reflect that the effort of rising is evidently a maximum, and that birds seldom perform it in a nearly vertical direction except for short distances, and that the exertion is clearly so severe that the feat is usually performed only by the smaller birds, which, as previously explained, must possess greater energy in proportion to their weight than those exceeding a few ounces. Heavy birds can only rise at angles less than 45°, and even then they exert for a short time far more than their mean strength, the latter being, for all animals, only a fraction of the maximum possible effort. Thus man, who is usually estimated as capable of exerting 0.13 horse power for 10 hours, can develop 0.55 horse power for $2\frac{1}{2}$ minutes, and nearly a full horse power for 3 or 4 seconds ; and it seems probable that similar proportions obtain for birds, the emergency effort being three or four times the average performance, and the possible maximum about twice as great as the emergency effort.

Pénaud states that the ring-dove dispenses in full flight 217 foot-pounds per minute ; but he does not give figures for this, so that they can be checked. Goupil estimates the work done by a pigeon weighing 0.925 lbs. at 1,085 foot-pounds per minute in hovering and 119 foot-pounds per minute in flight ; but the latter is arrived at by reasoning from analogy. It is evident that the power exerted in horizontal flight is much less than that required for rising or for hovering ; but until a bird is taught to tow behind him some dynanometric arrangement at a regular rate of speed, and on a level course, it will be diffi-



PASSENGER SALOON CAR, NEW ZEALAND RAILROADS.

* "Vol des oiseaux," page 92.

cult to settle exactly what are the feet-pounds expended in ordinary performance.

In 1889 Captain de Labouret, an expert in the solution of balistic problems, analyzed mathematically two series of photographs of a gull weighing 1.37 lbs., and just starting out in flight with 5 wing beats per second, as obtained by by Professor Marey with the chrono-photographic process. The calculations showed that the bird expended in this act an average of 3,152 foot-pounds per minute, or 2,303 foot-pounds per pound of his weight; and as Professor Marey shows that from his other observations of the reduced amplitude and rapidity of the wing beats, the same bird does only expend in full flight $\frac{1}{5}$ of the effort required at starting, the conclusion may be drawn that the gull in full flight expends some 460 foot-pounds per minute for each pound of his weight.

This estimate seems plausible to me, and agrees with my own figures, but it is not accepted by all aviators. The *Revue Scientifique* of November 28, 1891, contains two articles disputing the conclusions—one by Mr. V. Tatin, an expert aviator, who claims that the accelerations of the bird have been erroneously calculated; that the center of pressure under the wing is $\frac{1}{3}$ of the distance from its root instead of $\frac{2}{3}$, as usually assumed, and who figures out from the velocity of this new center of pressure, and from the known trajectory that the bird in full flight only expends from 33 to 197 foot-pounds per minute for each pound of his weight.

The second article is by Mr. C. Richet, the editor of the *Revue Scientifique*, who, having ascertained the volume of carbonic acid exhaled by a bird at rest, assumes, from experiments on other animals, that in full flight he will give out three times as much, and that the difference represents an effort of 105 foot-pounds per minute per pound of bird.

These two articles, being the most recent computations by earnest students of the subject, are here mentioned chiefly to illustrate how greatly aviators vary in estimates of the power expended, and how many elements have to be assumed in making such computations.

In the absence of direct measurements, and of positively satisfactory computation by others, of the feet-pounds expended in horizontal flight, I believe that an approximation may be obtained by analyzing and calculating the various elements which combine to make up the aggregate of the resistance to forward motion in horizontal progression; and as this method promises to be useful in computing the power required by artificial flying machines, I venture to set it out at some length, applying it to the domestic pigeon as being more convenient to compare with the results of the calculations of others. For this purpose two dead pigeons were selected, weighing as near as practicable 1 lb. each, and their dimensions were accurately measured as follows:

CROSS SECTION AND HORIZONTAL PROJECTION OF PIGEONS.

	Pigeon No. 1.	Pigeon No. 2.
Largest cross section of body	4.9 sq. in.	5.3 sq. in.
" " " edge of wings	5.02 " "	4.88 " "
Weight of bird, freshly killed	1 lb.	0.969 lb.
Horizontal area of both spread wings	90.35 sq. in.	99.86 sq. in.
" " " body projected	22.49 " "	24.01 " "
" " " tail spread	19.72 " "	27.17 " "
	132.56 sq. in.	151.04 sq. in.

These dimensions all require the application of coefficients in calculating their action upon the air. Thus the wings are concave, and give a greater sustaining power per square foot than a flat plane; the body is convex, and affords less than a plane, while the tail is slightly concave, but partly ineffective from its position. Previous experiments have indicated that, in the aggregate, the supporting power is about 30 per cent. more than that of a flat plane of equal area, so that in the calculations which follow the supporting surfaces will be assumed at 1.3 sq. ft. to the pound instead of the 1 square foot to the pound which the average of the measurements seems to indicate.

It will be remembered that experiments with parachutes indicate a coefficient of resistance of 0.768 for the convex side and of 1.936 for the concave side, as compared with the plane of greatest cross section.

The cross sectional area of the body is assumed at 5 square inches or 0.03472 of a square foot and to this a coefficient is applied of one-twentieth of a flat plane, or 0.05, in consequence of its elongated, fusiform shape. This agrees well with experiments on the hulls of ships of "fair" shape.

The cross sectional area of the wings is also taken at 5 square inches, or 0.03472 of a square foot; but the coefficient here assumed is about one-seventh, or 0.15, in consequence of its ogival shape, or rather something like only half of a Gothic arch.

The friction of the air is omitted, as being entirely too small to affect the results in a case where so many coefficients have to be approximated.

The angle of flight is ascertained by selecting from the table previously given of air reactions, the coefficient which will give the nearest approximation to a sustaining "lift" to support the weight, and from this angle the "drift" is obtained to calculate the resistance of the surface.

The velocity V is in feet per minute, and the pressure P on a plaue at right angles to the current by the Smeaton formula is in pounds per square foot. The following are the calculations:

20 miles per hour—$V = 1760$ ft. $P = 2$ lbs.

		Resistance.	Power.
Lift, 12°,	1.3 × 2 × 0.39 =	1.014 lbs. sustained.	
Drift, 12°,	1.3 × 2 × 0.0828 =	0.21580 lb.	× 1760 = 378.7 ft. lbs.
Body resistance,	0.03472 × 2 × 0.05 =	0.00347 "	× 1760 = 6.1 "
Edge wings,	0.03472 × 2 × 0.15 =	0.01040 "	× 1760 = 18.3 "
		0.22907 lb.	403.1 ft. lbs.

30 miles per hour—$V = 2640$ ft. $P = 4.5$ lbs.

		Resistance.	Power.
Lift, 5°,	1.3 × 4.5 × 0.173 =	1.012 lbs. sustained.	
Drift, 5°,	1.3 × 4.5 × 0.0152 =	0.08892 lb.	× 2640 = 234.7 ft. lbs.
Body resistance,	0.03472 × 4.5 × 0.05 =	0.00781 "	× 2640 = 20 6 "
Edge wings,	0.03472 × 4.5 × 0.15 =	0.02343 "	× 2640 = 61.9 "
		0.12016 lb.	317.2 ft. lbs.

40 miles per hour—$V = 3520$ ft. $P = 8$ lbs.

		Resistance.	Power.
Lift, 3°,	1.3 × 8 × 0.104 =	1.082 lbs. sustained.	
Drift, 3°,	1.3 × 8 × 0.00543 =	0.05647 lb.	× 3520 = 198.7 ft. lbs.
Body resistance,	0.03472 × 8 × 0.05 =	0.01389 "	× 3520 = 48.9 "
Edge wings,	0.03472 × 8 × 0.15 =	0.04166 "	× 3520 = 146.6 "
		0.11202 lb.	394.2 ft. lbs.

50 miles per hour—$V = 4400$ ft. $P = 12.5$ lbs.

		Resistance.	Power.
Lift, 2°,	1.3 × 12.5 × 0.07 =	1.137 lbs. sustained.	
Drift, 2°,	1.3 × 12.5 × 0.00244 =	0.03965 lb.	× 4400 = 174.5 ft. lbs.
Body resistance,	0.03472 × 12.5 × 0.05 =	0.02170 "	× 4400 = 95.5 "
Edge wings,	0.03472 × 12.5 × 0.15 =	0.06510 "	× 4400 = 286.5 "
		0.12645 lb.	556.5 ft. lbs.

60 miles per hour—$V = 5280$ ft. $P = 18$ lbs.

		Resistance.	Power.
Lift, 1½°,	1.3 × 18 × 0.052 =	1.217 lbs. sustained.	
Drift, 1½°,	1.3 × 18 × 0.00136 =	0.0318 lb.	× 5280 = 167.9 ft. lbs.
Body resistance,	0.03472 × 18 × 0.05 =	0.0312 "	× 5280 = 164.7 "
Edge wings,	0.03472 × 18 × 0.15 =	0.0937 "	× 5280 = 494.7 "
		0.1567 lb.	827.3 ft. lbs.

These figures are probably somewhat in excess of the real facts in consequence of the adoption of slightly excessive coefficients for the resistance of the body and wing edges, which coefficients in full flight may be as much as one-third less than those which have been estimated.

It will be noticed that, as the velocity and the consequent air pressures increase, the angle of incidence required to obtain a sustaining reaction or "lift" diminishes, and so does, therefore, the "drift" or horizontal component of the normal pressure, while the "hull resistance," consisting of that of the body and edges of the wings, is at the same time increasing. There will therefore be some angle at which these various factors will so

combine as to give a minimum of resistance, and this is probably for most birds at an angle of about 3°, which in the case of our calculated pigeon requires a speed of 40 miles per hour in order to sustain the weight.

This angle of minimum resistance depends upon the relative proportions of the bird—*i.e.*, upon the ratio between his surface in square feet per pound of weight, and the cross section of his body and wings, as well as their coefficient of resistance; and so, while the angle may not vary greatly, it needs to be ascertained for each case. Mr. Drzewiecki has calculated that for an aeroplane exposing a cross sectional area of one per cent of its sustaining area (instead of the seven per cent which the measurements show for the pigeon), the angle of minimum resistance would be 1° 50′ 45″, and that it would be the same for all velocities. It does not follow, however, that the minimum of power required will coincide with the minimum of resistance, for the latter increases as the square, while the power grows as the cube of the speed. The calculations, therefore, show that the minimum of resistance occurs at 40 miles per hour, while the minimum of work done in foot-pounds is found at 30 miles per hour, and these two favorable speeds are about those observed from railway trains, as habitually practised by the domestic pigeon.

The estimates of the feet-pounds per minute indicate that the bird finds it less fatiguing to fly at 30 miles per hour than at 20; that his exertions are not much greater at 40 miles per hour, but that at 50 miles per hour he is expending rather more than his mean strength—the latter being probably about 425 foot-pounds per minute, nearly an average of the first four calculations, or about one-quarter of the maximum work done in rising, as estimated by Pénaud.

A flight of 60 miles within the hour is probably a severe exertion for the domestic pigeon, while the finer lines and greater endurance of the carrier pigeon enable him to maintain this speed for hours at a time; but there is reason to believe that this must be nearly the limit of his strength, and that homing birds who have made records of 70 and 75 miles per hour were materially aided by the wind.

The calculations therefore appear plausible, and to agree fairly well with the estimates arrived at with different methods by others. They indicate that if a flying machine can be built to be as efficient as the domestic pigeon, its motor should develop one horse power for each 18 lbs. of its weight, provided it can give out momentarily about four times its normal energy, or that special devices, such as that of running down an incline or utilizing the wind, or some other contrivance are adopted to give it a start and to enable it to rise upon the air.

The next question which the reader will probably want to ask, is as to the amount of supporting surfaces possessed by birds in proportion to their weight. Upon this point a good deal of information has been published; and in 1865 Mr. De Lucy greatly cheered aviators by publishing a paper in which he showed that the wing areas of flying animals diminish as the weight increases, from some 49 square feet to the pound in the gnat to 0.44 square feet to the pound in the Australian crane; and from which tables he inferred the broad law that the greater the weight and size of the volant animal, the less relative wing surface it required.

As thus stated, the assertion is misleading. For inasmuch as the supporting surfaces will increase as the square, and the weight will grow as the cube of the homologous dimensions, it was to be expected that wing surfaces would not increase in the same ratio as the weight if the strength of the parts remained the same; and in 1869 Hartings published some tables of birds, in which he compared the square root of the wing surface with the cube root of the weight, and showed that their ratio became what he considered a somewhat irregular constant. Subsequent measurements and tables by Professor Marey have shown that this statement of Hartings is also slightly misleading, inasmuch as the so-called constant varies from 1.69 to 3.13, so that no broad law can be laid down as to any fixed relation between the surfaces and weight of birds of various sizes. The fact seems to be that while their structures are governed by the laws which limit the strength of materials (bones, muscles, feathers, etc.), yet there are differences in the resulting stresses, and in the consequent efficiency of the birds themselves, who are thereby led to adopt slightly different modes of flight; and in 1884 Müllenhoff published an able paper, in which he divided flying animals into six series, in accordance with the ratio between their weight and their wing surface, as well as their methods of flight. As the tables of De Lucy, Hartings,

TABLE OF SUPPORTING AREAS OF BIRDS.
MEASURED BY L. P. MOUILLARD.
COMPILED BY S. DRZEWIECKI.

Scientific Name.	Common Name.	Sq. Ft. per Lb.	Lbs. per Sq. Ft.	Corr'sp'ding speed for a plane at 3° Miles per hr
Nyctinomous ægypticus	Bat	7.64	0.131	15.9
Upupa epops	Peewit	3.62	0.276	23.1
Cotile rupestris	Swallow	3.62	0.276	23.1
Budytes flava	Wagtail	3.49	0.286	23.5
Galerita cristata I	Lark	3.18	0.315	24.6
Caprimulgus	Goatsucker	3.17	0.314	24.6
Galerita cristata II	Lark	3.06	0.327	25.1
Accipter nisus	Sparrow-hawk	3.00	0.333	25.3
Pteropus Geoffroyi	Bat	2.79	0.362	26.2
Coracias garrulus	Roller	2.76	0.363	26.5
Tringa canutus	Knot	2.64	0.380	27.0
Falco tinnunculus	Falcon	2.48	0.403	27.9
Passer domesticus I	Sparrow	2.42	0.414	28.2
Vanellus cristatus	Lapwing	2.40	0.417	28.3
Passer domesticus II	Sparrow	2.36	0.424	28.6
Cypselus apus	Martinet	2.35	0.426	28.6
Larus melanocephalus I	Gull	2.35	0.426	28.6
Glareola torquata	Glareola	2.32	0.431	28.8
Larus melanocephalus II	Gull	2.30	0.435	28.9
Turtur ægypticus	Egyptian Dove	2.27	0.441	29.2
Otus brachyotus	Owl	2.26	0.443	29.2
Strix flammea	"	2.26	0.443	29.2
Milvus ægypticus	Kite	2.19	0.457	29.7
Petrocincla cyanea	Blackbird	2.18	0.460	29.7
Alcedo hispada I	Kingfisher	2.11	0.475	30.3
" " II	"	2.11	0.475	30.3
Buphus minutus	Crane	2.02	0.495	30.9
Scolopax gallinula I	Snipe	1.96	0.510	31.4
Ephialtes zorca	Scops	1.90	0.526	31.8
Alcedo hispida III	Kingfisher	1.87	0.535	32.1
Corvus ægypticus	Rook	1.74	0.575	33.3
Astur palumbarius	Goss-hawk	1.73	0.579	33.4
Ibis falcinellus	Ibis	1.66	0.603	34.1
Sturnus vulgaris	Starling	1.65	0.606	34.2
Scolopax capiensis	Snipe	1.65	0.606	34.2
Corvus corax	Raven	1.62	0.614	34.5
Scolopax gallinula II	Snipe	1.60	0.625	34.7
Philomachus pugnax	Water-fowl	1.48	0.634	36.1
Ardea nycticorax	Night Heron	1.43	0.700	36.7
Ciconia alba	Stork	1.40	0.715	37.1
Charadrius pluvialis	Plover	1.38	0.725	37.4
Columbia ægyptica I	Egyptian pigeon	1.37	0.730	37.5
Falco peregrinus	Falcon	1.29	0.775	38.6
Rallus aquaticus	Rail	1.28	0.781	38.8
Pandion fluvialis	Balbuzzard	1.26	0.795	39.2
Neophron percnopterus	Egypt'n vulture	1.18	0.848	40.4
Columba ægyptica	" pigeon	1.13	0.885	41.3
Numenius arquatus	Ceulis	1.11	0.901	41.7
Ortyx coturnix	Quail	1.08	0.927	42.3
Recurvirostra avocetta	Avocetta	1.05	0.954	42.8
Œdicnomus crepitans	Plover	0.926	1.079	43.6
Anas querquedula	Duck	0.864	1.158	44.2
Puffinus Kulhi	Shearwater	0.853	1.170	44.5
Gallinula chloropus	Water-hen	0.765	1.307	50.3
Numenius arquatus	Curlew	0.761	1.312	50.3
Pelecanus anocrotales	Gray Pelican	0.732	1.365	51.3
Gyps fulvus	Tawny Vulture	0.679	1.473	53.3
Otogyps auricularis	Oricou	0.664	1.473	53.9
Pterocles exustus	Running Pigeon	0.664	1.508	53.9
Procellaria gigantea	Giant Petrel	0.640	1.561	54.9
Anser sylvestris	Wild Goose	0.586	1.708	57.4
Meleagris Gallopavo	Turkey	0.523	1.910	60.6
Anas clypeata, female	Duck	0.498	2.008	62.2
" " male	"	0.439	2.280	66.2

Marey and Müllenhoff are all easily accessible in print, they will not be repeated here; but the following table is considered more valuable than any of them. It has been compiled from "L'Empire de l'air" of Mr. Mouillard, a very remarkable book, published in 1881, which contains descriptions of the flight of many birds and accurate measurements of their surfaces and weights.

Mr. Mouillard adopted a more rational method than other observers. Instead of merely measuring the surface of the wings, he laid the bird upon its back on a sheet of paper, projected the entire outline, and then measured the total area from which it gains support. The compilation has been made by Mr. Drzeweicki for a paper presented to the International Aeronautical Congress at Paris in 1889, in which he states the general law more accurately than his predecessors, by calling attention to the fact that the ratio of weight to surface will vary somewhat with the structure of the bird, and that the result will be that those possessing the lesser proportionate surface must fly faster in order to obtain an adequate support at the same angle of incidence.

I have added the last column in the table, showing the speed required to sustain the weight of a flat plane loaded to the same proportion of weight to surface as the bird, at an angle of incidence of 3°. This speed merely approximates to the real flight of the bird, because it takes no account of the concavity of the wings, which, as previously explained, increases the effective bearing surface of the animal; but it would require experimenting with each and every bird tabulated in order to give the true and varying coefficients.

(TO BE CONTINUED.)

THE ARMOR-PLATE TRIALS.

THE last of the series of armor-plate tests, to which reference has been made in our columns, took place at the Indian Head proving grounds on January 13. Two plates remained to be tried—a low-carbon, untreated plain steel, and a high-carbon nickel-steel treated by the Harvey process; both plates were made by Carnegie, Phipps & Company. These plates were originally of the same size as the others treated, 6 × 8 ft., and 10½ in. thick. In consequence of a defect in the nickel-steel plate 20 in. were cut off, leaving it that much shorter; while to take out a warp in the plain steel plate, caused by successive temperings, the edges had been planed down about 1 in., leaving the center of the plate of full thickness. To offset the difference in the size of the plates, only three 6-in. shots were fired at the nickel-steel plate, these being aimed at the points of an isosceles triangle, 2 ft. from the upper edge and the two sides; this was one shot less than in the other tests. One 8-in. shot was fired at the center.

In the tests alternate shots were fired at the two plates, beginning with the plain steel. That plate was practically wrecked, all four of the 6-in shots having gone through it and lodged in the backing. The second shot broke off the upper right-hand corner, and the others, besides fracturing, produced cracks in several directions. The 8-in. projectile went through the plate and backing, and was picked up 50 ft. distant, having been very little injured.

The first of the three 6-in. projectiles fired at the nickel-steel plate penetrated it to a depth of 9 in. and rebounded. The second shot acted very much the same way as one of the shots at the nickel-steel plate in the previous trials. The point of the projectile was apparently welded to the plate, and the remainder was broken up into pieces. The penetration was estimated at about 4 in. The third 6-in. shot at this plate remained in the plate, the base projecting 6½ in. It is stated that no cracks were developed by any of these shots. The fourth shot, which was from the 8-in. gun, and which was fired at the center of the plate, went through the plate and backing and remained imbedded in the sand beyond. After this shot three cracks appeared, one extending from the center to the top of the plate, and the other to the lower right and left-hand corners; each crack passed through one of the marks left by the 6-in. shot, practically separating the plate into three parts. It should be borne in mind that the shots at this plate were grouped more closely together than had been done upon any of the other plates tested.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXV.—BEARING METALS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(Continued from page 16.)

THE question as to what metal to use for bearings under cars is one which will be recognized when mentioned as of the very highest importance to railroads. It is believed by many that the bearing metal is largely at fault for those annoying delays in transportation due to what are known as "hot-boxes," and although our studies and investigations have hardly led us to such a conclusion as this, yet it cannot be denied that the metal itself used in the bearings has a good deal of influence upon the successful movement of trains. The importance of the question is likewise re-enforced by another consideration—namely, loss of the metal by wear. When it is considered that the bearing metal is expensive, costing possibly anywhere from 12 to 20 cents per pound, and that each car, on the average, loses eight pounds of this metal for every 25,000 miles that it runs, it is readily seen that the item of wear of bearing metal comes in as quite an important factor in the cost of operating a railroad. It only requires a little calculation based on the above data to show that on any large railroad the loss of bearing metal by wear might readily amount to from $100,000 to $150,000 per year.

In view of both of these considerations we have devoted a good deal of time and experimentation to the question of what kind of bearing metal is the best to use. Some 20 years ago the standard bearing metal was a copper-tin alloy, seven pounds of copper to one pound of tin, commonly known as "cannon bronze." This alloy is, even to this day, possibly with slight modifications in the proportions, largely used for bearings, but, as will be seen a little later, we think, not at all wisely. The first experiments made with bearing metal alloy were to compare this copper-tin alloy with what will be called the standard phosphor-bronze bearing metal, and which will be described in detail a little farther on. The results of these experiments, which were quite extended, proved conclusively two things: First, that the copper-tin alloy was much more liable to heat under the same state of lubrication than the standard phosphor-bronze bearing metal, and, second, that the rate of wear with the copper-tin alloy was nearly 50 per cent. greater than that of the standard phosphor-bronze bearing metal—that is to say, if the standard phosphor-bronze lost a pound of metal every time a bear-

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs.

ing went 25,000 miles, the copper-tin alloy would lose 1½ lbs. under the same conditions. These experiments led to the adoption of what has already been called the "Standard Phosphor-Bronze Bearing Metal," as the almost exclusive metal to be used for car bearings on the Pennsylvania Railroad, and for a period of years following these experiments nothing else, practically, was used for this purpose.

The *Phosphor-Bronze Bearing Metal* will bear a few words of elucidation and explanation. It is well known by those who are informed on the progress of metallurgy that Messrs. Levy and Kunzel made experiments, now nearly 20 years ago, with the idea of developing an alloy which could be successfully used in making cannon. These experiments were carried on on a large scale, and the results have been published in a *brochure*, which has been furnished to most of the large governments of the world. The experiments of these gentlemen culminated apparently in the development of an alloy of copper, tin, and phosphorus which had quite remarkable properties. The addition of phosphorus to a copper-tin alloy seems to increase the tensile strength and elongation, and to make it a very much easier metal to manipulate in the foundry—that is to say, phosphorus being present in a copper-tin alloy, a very much larger percentage of sound castings will be obtained than if the phosphorus is not present; also, these castings will have greater tensile strength and greater elongation. Following the knowledge of this fact came another one which, so far as bearing metals are concerned, is perhaps of equal importance—namely, Mr. C. J. A. Dick, of London, discovered that the addition of lead to a copper-tin-phosphorus alloy gave a resulting alloy which under abrasion was very much superior to anything at that time known, and he accordingly took out a patent for a phosphor-bronze containing lead to be used as bearing metal. It is practically this metal which was used, as above referred to, for a period of time as the standard bearing metal of the Pennsylvania Railroad Company.

For quite a long time while Mr. Dick's patent was in force this metal was made of standard composition and quality by the Phosphor-Bronze Smelting Company, of Philadelphia. Ultimately, as the time of the patent was about to expire, and as other manufacturers recognized the value of the phosphor-bronze bearing metal and began to prepare to make it, it became essential for the Pennsylvania Railroad Company, in order to protect its interests, to prepare specifications for this metal, which was accordingly done. These specifications are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Specifications for Phosphor-Bronze Bearing Metal.

From this date Phosphor-Bronze Bearing Metal will be purchased in amounts of 20,000 pounds, or some whole multiple of this number. Manufacturers will be required to notify the General Superintendent Motive Power, at Altoona, when they are ready to ship 20,000 pounds, and await the arrival of the Company's Inspector, and have proper assistance and all facilities ready for shipping the metal as soon as the Inspector arrives.

The Inspector will see the metal weighed and shipped, and will select three half pigs to represent the shipment. He will also be at liberty to reject any pigs in which want of uniformity in the constituents is evident to the eye.

Mixed borings from the three half pigs will be analyzed, and the shipment will be accepted or rejected on this analysis.

The metal desired has the following composition:

Copper	79.70 per cent.
Tin	10.00 "
Lead	9.50 "
Phosphorus	0.80 "

Shipments will not be accepted if the analysis as above described gives results outside the following limits: Tin, below 9.00 per cent., or over 11.00 per cent.; Lead, below 8.00 per cent., or over 11.00 per cent., and Phosphorus below 0.70 per cent., or over 1.00 per cent., nor if the metal contains a sum total of any other substances than Copper, Tin, Lead, and Phosphorus in greater quantity than 0.50 per cent.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., June 14, 1889.

The above is the second revision of these specifications. The specifications seemed to be sufficiently clear on inspection and very little difficulty has arisen in regard to them. All the manufacturers, of whom there are now some five or six, seem to be competent to make metal which will come within the limits given at the end of the specifications, and it is very rare indeed that we have occasion for complaint or to reject a shipment. Since the phosphorus is the most expensive constituent in the metal, it might be thought there was no real reason why there should be an upper limit, and that in reality we would be glad to have as much phosphorus as possible. In the first specifications issued no upper limit was provided, and it was found that, either on account of carelessness or of unequal distribution of the phosphorus, we occasionally got metal considerably higher than the limits given. A direct experiment with this high phosphorus metal showed that it was so extremely fluid that it was difficult to hold it in the sand, and accordingly we placed an upper limit of phosphorus.

We believe the manufacturers use phosphorus enough, so that if all of it should get into the metal it would make about 1.00 per cent. The average of our analyses shows not far from 0.80 per cent. in the finished metal as we receive it, the balance being lost in the process of introducing the phosphorus.

It will be observed that practically no other substances are allowed to be present in this alloy except copper, tin, lead, and phosphorus. There is a twofold reason for this: First, zinc is a very much cheaper constituent than any of the others except lead, and the tendency of the manufacturers would be to introduce zinc to the extent of a few per cent. There would be two reasons for this tendency: First, the diminution in the resulting cost of the alloy; and, second, it is well known that the quadruple alloy of copper, tin, lead and zinc is a much easier manipulated metal than a copper-tin alloy, or, indeed, than a copper-tin-lead alloy. The phosphorus undoubtedly facilitates the foundry manipulation of the metal, but so does the zinc; and without any control over the metal, and limitations moderately rigidly enforced the tendency would be to give a copper-tin-lead-zinc alloy with very much less phosphorus. While we believe in the value of zinc in copper-tin-lead alloys, we think it advisable to introduce it ourselves in our own foundry, if we decide to put it in, and accordingly, as will be observed, the limitations are moderately strict on this point. There is still another reason for excluding the introduction of other substances than copper, tin, lead and phosphorus—namely, according to present experience a copper-tin-lead alloy containing phosphorus is the best bearing metal known. If now we allow other substances to be introduced it becomes more difficult to locate the cause of trouble when hot-boxes arise than if we have a standard bearing metal. It is not uncommon for the laboratory to receive bearings from the service which have heated with the request to know if there is anything in the bearing metal which will account for the difficulty. If old junk and miscellaneous metals are allowed to be used in the bearing metal we would, of course, find it very difficult to say that the cause of the hot-boxes must be looked for otherwheres than in the bearing metal. The effect of this on the efficiency of the service will be readily appreciated by any railroad operating officer.

It is perhaps worthy of note that the success of the phosphor-bronze bearing metal has been so great that attempts have been made by a number of parties to secure the same metal in other ways. The most notable attempt of this kind has been the effort to sell to the railroad companies a phosphor-tin and then allow them to make their own bearing metal by using the proper proportions of the phosphor-tin to secure the right amount in the resulting alloy of both tin and phosphorus. So far as we know there is really no objection to this method of making the bearing metal, but, so far as our experience has gone, it is extremely difficult to obtain in the market a phosphor-tin rich enough in phosphorus so that the amount required in our specifications would appear in the finished bearing. The manufacturers of the phosphor-tin alloy do not apparently sufficiently understand their work to enable them

to make an alloy containing 7.00 or 8.00 per cent. of phosphorus, at least at a price which will enable this alloy to compete with the phosphor-bronze as it is now ordinarily made. Of course, if the consumers of the phosphor-bronze bearing metal are willing to accept less phosphorus than is characteristic of the metal described in the above specifications it is undoubted that a good alloy could be made in this way. The lower limit of phosphorus in our specifications is more a commercial question than one of actual value in the service so far as we know. Our position in this matter is as follows: Every melting of the metal causes a little loss of phosphorus, and as we do not know how many times we may want to remelt this metal we start with a good lot of phosphorus, the lower limit being 0.70 per cent. We have no experiments to prove that if the finished bearing has 0.40 per cent. of phosphorus in it the bearing would not be just as good in service, but as the scrap bearings are remelted we are sure the scrap would not be as valuable as it would if it had 0.70 per cent. It is entirely probable that the makers of phosphor-tin will learn within a short time how to make an alloy of phosphorus and tin which shall meet every requirement, and if this is possible it will introduce another source of competition in bearing metal material which will undoubtedly redound to the benefit of the consumers.

Notwithstanding the successful results obtained with the standard phosphor-bronze bearing metal it was not deemed advisable to allow the question to rest here, and accordingly with more or less frequency during all the time since the phosphor-bronze bearing metal was established as standard experiments have been made with other alloys to see if any improved results could be obtained. It is entirely possible that not less than 20 to 25 different bearing metal alloys have been experimented with during the past 15 years. The usual method of experimentation is to have either eight, or twelve, or sixteen bearings cast of the standard phosphor-bronze and a like number of the metal under trial. These bearings are all carefully weighed and stamped, a record being made in a book kept for the purpose of these weights and numbers. They are then put in service, usually on engine tenders, a standard phosphor-bronze bearing and a trial bearing being on opposite ends of the same axle. Also one-half the trial bearings and one-half the standard bearings are on each side of the tender, so as to eliminate as much as possible any conditions favoring one bearing or the other. This arrangement, as will be observed, brings a standard bearing, we will say, on one side of the tender next to the engine. Following down that side the next would be a trial bearing, the next a standard bearing, and the next a trial bearing, and on the opposite side the reverse. This method, it will be observed, is strictly a comparative one. No attempt is usually made to keep a record of the mileage, since it is found that the wear of bearings is very variable compared with the mileage, possibly due to location where the work is done—that is, whether the work is largely on grade or curves, also due to the state of lubrication, and also due to the variation in the load in the tender. On the other hand, the loss of metal by wear of the trial bearing is strictly comparative with the standard bearing metal, and the results obtained in this way are believed to be very valuable indications. If the trial on tenders shows that the proposed new alloy has promise, a second trial may be made more extended on locomotive tenders, or possibly two or three hundred bearings of each kind may be put on cars. This has been done in several cases. At the end of the trial the bearings are removed from service and re-weighed and the loss of metal of each trial bearing is compared with the loss of metal of its opposite standard bearing. Averages, of course, are made of the whole lot. It frequently happens that, owing to the exigencies of the service, a trial bearing or its opposite may be lost, and in making up the averages these odd bearings are rejected. During the trial, of course, careful attention is paid to the heating, which is regarded as of great importance. Some trial alloys have actually not run three days without one-half or two-thirds of them heating. Under such conditions the trial is, of course, discontinued at once.

It would hardly be worth while to go into the details of all the experimental alloys that have been tried in the manner described above. It is perhaps sufficient to say that three points have been brought out quite clearly so far as we are concerned—namely:

First, the loss of metal by wear under exactly the same conditions diminishes with the increase in lead.

Second, the loss of metal by wear under the same conditions diminishes with a diminution of tin.

Third, the phosphorus in a copper-tin-lead-phosphorus alloy, apparently is very much more valuable in the foundry than in the service; indeed, its principal value, so far as the service is concerned, consists in the help that it gives in getting sound castings.

We have no evidence to show that the phosphorus has any valuable influence on the wear except as stated above. In other words, if we had two bearings of practically the same proportions, one made of copper, tin, lead alone, and the other made of copper, tin, lead and phosphorus, and both were equally sound castings, we have no experiments that indicate that the one containing phosphorus would wear any better than the one without phosphorus.

In view of the results stated above, the question arose some three or four years ago with some prominence as to how much lead and how little tin we could get along with. Quite a number of experiments were made on this point, with the result of finally reaching the following composition as the best that could be obtained with our present knowledge—namely:

Copper	77.00 per cent.
Tin	8.00 "
Lead	15.00 "

This alloy from the letter assigned to it in the experimental work done is known as "Ex.B" metal. It will be observed that in the figures given above there is no phosphorus, and this was the case with the experimental alloy which led to the adoption of the figures mentioned. On the other hand, as will be readily understood, there are considerable amounts of phosphor-bronze scrap constantly coming back to the foundry for remelting. Accordingly, such a formula was devised as would enable this scrap to be used in making the standard Ex.B metal, and at the same time would give the advantage in foundry practice of having a small amount of phosphorus in the alloy. We give below working formulas which enable a foundry to use larger or smaller amounts of scrap, depending on the amount received from the service. It will also be fair to state that we deem the presence of a small amount of phosphorus in the alloy as of sufficient importance in the foundry, so that if there is no scrap we recommend to put in new standard phosphor bronze. These points are covered in the working formulas as follows:

Copper	105 lbs.	90 lbs.	72½ lbs.
Phosphor-Bronze, New or Scrap.	60 "	80 "	100 "
Tin	9¾ "	7½ "	5½ "
Lead	25½ "	22½ "	22 "

These formulas all give a bearing metal of about the following composition:

Copper	76.50 per cent.	to 76.80 per cent.
Tin	8.00 "	
Lead	15.00 "	
Phosphorus	0.50 "	to 0.20 "

The above formulas enable the foundry to make a standard bearing metal which, so far as our knowledge at present goes, is the best one known; but there is one point still not covered in these formulas—namely, it is clear, of course, that after awhile the foundry would begin to receive Ex.B scrap, and it would not do to put this in in place of the phosphor-bronze scrap, because the proportions of the constituents are different, and also because the amount of phosphorus in the Ex.B metal is small. Accordingly, a working formula has been calculated out which enables the foundry to dispose of the Ex.B scrap which comes to it. This formula is as follows:

Ex.B Scrap	80 lbs.
Phosphor-Bronze, New or Scrap	20 "
Copper	76 "
Tin	7 "
Lead	17 "

It will be observed that, even in this formula, which was calculated out for the sake of enabling the foundry to use large quantities at one time of the Ex.B scrap, some new or scrap phosphor-bronze is used, the object being to keep up the phosphorus in the bearings to not less than about 0.2 per cent.

The above series of working formulas will enable any foundry to make bearings like the standard bearings of the Pennsylvania Railroad without any difficulty and provide for the use of their scrap bearing metal. It is perhaps advantageous to add that the formulas calculate for 200-lb. pots, and that in the melting it is not essential to add the copper to the pot and melt it down before adding the other constituents. In actual practice the copper and scrap together with the new phosphor-bronze are all charged at once, care being taken to keep the pot covered with powdered charcoal during melting. The lead and tin are not added until after the pot is taken from the fire. It is also fair to say that there is one characteristic in regard to the foundry practice, which it is important to observe—namely, the metal must not be cast at too high temperatures. A very injurious segregation of the constituents takes place if the metal is cast, even in as small a casting as a car bearing, at too high temperatures. Instead of the fine-grained fracture, which is characteristic of metal properly treated, bearings that are poured too hot are coarse crystalline, and in every sense inferior. In the early days of the use of phosphor-bronze very serious difficulty arose from this cause. It is customary in a well-organized foundry to temper the metal, as it is called, for pouring, by the addition of borings from previous bearings. It is, of course, understood that no bearings are sent to the service with the foundry skin on the part that rests on the axle. This is always taken off and the bearing bored out to the proper radius before the bearings are turned out. These borings are used for tempering. Of course the tin and lead added to the metal after it is taken from the fire always temper it a little bit. We know of no rule by which the actual temperature fit for pouring can be determined, but the general practice should be to cast at as low temperatures as will give successful work.

While upon the subject of bearing metal it is perhaps fair to discuss a little the question of lead lining. It is doubtless well known that the common practice now made use of, and which is recommended everywhere for bearings, is to lead line everything which goes into the service. The principal reason for this lining of lead on the inside of the bearing is to furnish a layer of soft, rather easily displaceable metal which will enable the bearing to adapt itself to the worn journal without giving an excessive pressure per square inch. There seems little doubt but that the practice of lead lining diminishes the difficulty of adapting the bearings to worn journals very greatly. It is obvious that it will be impossible to have the bearings turned to the same radius as every worn journal in service, and the lead-lining device meets this difficulty in a very satisfactory way.

It has been stated once or twice in the course of the preceding remarks that it is believed the Ex.B metal represents the best composition for bearing metal now known. It is not at all intended to claim that it is the best that can be developed. All we can say is that all the experiments made show that, both in regard to heating and in regard to loss of metal by wear no other bearing metal that we have experimented with gives as good results as the Ex.B metal. It is entirely possible that a still further diminution in tin, and increase in lead, might give better results. Just where the line should be drawn as a finality it is impossible to say at the present moment. Experiments have been made diminishing the tin in the Ex.B metal one-half, but a very funny difficulty was met with in attempting to make bearings of such an alloy. It is well known that lead and copper do not alloy, and on trying to make a bearing with about 20 per cent. of lead and 4 per cent. of tin, the remainder being copper, it was found almost impossible to get a homogeneous alloy due to the separation of the lead. Apparently one function of the tin, in the triple alloy of copper, tin and lead, is to hold the lead alloyed with the copper. It is quite probable that a small diminution in tin from what is characteristic of the Ex.B metal might take place, and also possible that a small increase in lead might take place. We have not yet finally put this question at rest. It is also possible that the introduction of other constituents into the bearing metal alloy, or, indeed, other combinations of the five or six metals available for bearing metal purposes—namely, copper, tin, lead, antimony and zinc, either with or without phosphorus, might give a bearing metal better than anything else we now know of. This field still remains for experiment.

The question of the crushing or distortion of the bearing under the pressures used is one that has received considerable attention in the course of our experiments. No difficulty has been experienced on this point, either with the standard phosphor-bronze, or with the standard Ex.B metal. Some of the white metal alloys, however, notably the alloy of lead and antimony, either with or without a small addition of zinc, or a little bit of copper, or an alloy of lead, tin and antimony, or, indeed, any of the white metal alloys made from zinc, tin, lead and antimony, have so much difficulty from this cause, that we do not know of any successful car bearings made wholly from white metal. Accordingly, it is customary when trying to use any of these white metal alloys for bearings, to put them inside of a stronger shell, giving rise to the well-known filled car bearing. There is a good deal of chance for experiment in this field yet, and we are frank to say that our experiments have not covered as much ground in this direction as we could wish. There is some knowledge which indicates that the use of a white metal alloy of the right composition would possibly diminish some of the difficulty now experienced with the present standard bearing metal —notably, a less tendency to heat, and possibly a diminution in friction. This field remains, however, for further experiment, and experiments on this point are in progress. Experiments on bearing metals containing aluminum have been undertaken, but no results have yet been obtained.

In the next article we will try to answer the question, "How to Make a Specification," and hope to follow this by another article on "Sampling and Enforcement of Specifications."

(TO BE CONTINUED.)

Foreign Naval Notes.

A NEW Russian armored ship has recently been completed at Sebastopol, and will be added to the Black Sea fleet. This ship, which has been named *George the Victorious*, is 340 ft. long, 69 ft. beam, 26 ft. deep, and 10,280 tons displacement. The engines will work up to 16,000 H.P. with forced draft, and will give, it is expected, a speed of 14 knots with natural draft, and 17.5 knots with forced draft. The main battery consists of six 12-in. guns mounted in barbette, and seven 6-in. guns on the battery deck. The secondary battery includes eight Baranooski rapid-fire guns and six 37-mm. rapid-fire guns; there are also seven torpedo-tubes.

ON December 18 a test of a Cammell solid steel armor plate was made on the *Nettle*, at Portsmouth, England. The plate was 10½ in. thick and weighed 10 tons. Five rounds were fired from a 6-in. gun at a distance of 30 ft., a charge of 48 lbs. of powder being used, with projectiles weighing 100 lbs. Three of these were Holtzer armor-piercing shell, and it is stated that two of them rebounded, doing but slight damage, while the third remained in the plate, but did not crack it. The other two projectiles were Palliser chilled shot, and did no damage to the plate. The plate was made by a new process, which is kept secret.

A NEW ENGLISH CRUISER.

ONE of the latest additions to the English Navy is the cruiser *Thetis*, which is one of three built by James & George Thompson, of Clydebank, Scotland. This vessel is a second-class cruiser of the following dimensions: Length, 300 ft.; breadth, 43 ft.; depth, 22 ft. 9 in.; average draft, 16 ft. 6 in.; displacement, 3,400 tons. She has a protective deck extending the whole length of the vessel in the form of a flat arch, the crown of which rises about 1 ft. above the water-line at the center of the ship, and slopes down to a point about 4 ft. below the load-line at the sides. This deck is 2 in. thick on the slope and 1 in. on the crown, and covers the engines, boilers and other machinery and the magazines. Protection for the parts of the engine which are above this deck is obtained by a belt of 5-in. armor with teak backing surrounding the engine hatchway. The ship is divided into 80 water-tight compartments, and has an inner bottom under the engine and boiler space.

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1891.

Name of Road.	Number of Locomotives on Road.	Number of Locomotives in Service.	Mileage of Locomotives. Total.	Mileage of Locomotives. Average per Engine.	Average Number of Passenger Cars per Train.	Average Number of Loaded Freight Cars per Train.	Coal Consumed per Mile. Passenger Train Mile.	Coal Consumed per Mile. Freight Train Mile.	Coal Consumed per Mile. Working and Switching Mile.	Coal Consumed per Mile. Average for all Engines.	Coal Consumed per Mile. Per Passenger Car Mile.	Coal Consumed per Mile. Per Loaded Freight Car Mile.	Cost of Locomotives per Mile. Repairs.	Cost of Locomotives per Mile. Fuel.	Cost of Locomotives per Mile. Oil, Waste, Tallow, etc.	Cost of Locomotives per Mile. Other Accounts.	Cost of Locomotives per Mile. Wages, Engineers and Firemen.	Cost of Locomotives per Mile. Cleaning and Attendance.	Cost of Locomotives per Mile. Total.
							Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Atchison, Top. & Santa Fé.	802	706	2,167,779	3,070	....	....	.....	.....	.....	85.65	.....	....	5.41	7.20	0.31	0.14	6.68	1.50	21.24
Canadian Pacific	567	...	1,824,895	3,219	....	.....	.....	.....	.....	69.81	.....	....	3.92	11.02	0.37	....	5.33	1.16	21.80
Chesapeake & Ohio*	...	244	802,044	3.287	4.64	22.81	68.40	131.55	56.05	100.88	14.76	5.76	3.75	3.56	0.36	1.72	6.04	0.28	15.71
Chic., Burlington & Quincy	...	480	1,723,680	3,591	4.56	18.08	.....	.....	.....	91.45	.....	....	3.68	6.41	0.21	0.35	6.63	...	17.28
Chicago & Northwestern	...	846	2,807,531	3,318	....	.....	.....	.....	.....	90.14	.....	....	3.20	8.01	0.36	....	6.32	0.78	18.67
Chicago, Rock Is. & Pacific	...	536	1,814,571	3,385	....	....	.....	.....	.....	61.18	.....	....	2.69	6.10	0.23	...	6.53	....	15.55
D., L. & W., Main Line	208	200	693,725	3,469	....	.....	.....	.....	.....	80.44	.....	..	2.94	6.18	0.35	....	5.97	...	15.44
Lake Shore & Mich. South.	560	536	1,792,960	3,345	...	....	55.36	84.07	....	60.13	.....	....	3.01	4.79	0.16	....	6.97	0.19	15.12
Louisville & Nashville*	...	357	1,723,336	†3,772	5.08	15.76	61.16	103.70	48.43	79.84	12.80	6.35	4.41	6.55	0.26	1.33	6.16	0.58	19.29
Manhattan Elevated	...	276	821,746	2,977	....	.....	.....	.....	....	38.91	.....	....	2.40	7.90	0.30	...	8.90	....	19.50
Milwaukee, Lake S. & W.	112	103	273,040	2,651	....	.....	.....	.....	....	80.03	....	...	2.95	11.95	0.29	....	6.09	1.16	22.44
N. Y., Lake Erie & West.‡	...	617	1,787,783	2,897	4.60	21.20	89.50	127.00	71.30	.....	19.30	6.00	4.92	7.64	0.40	1.92	7.28	1.08	23.24
N. Y., Pennsylvania & Ohio	...	264	703,181	2,664	5.10	18.20	74.30	132.00	68.70	.....	14.60	7.20	4.32	6.76	0.32	2.36	6.78	1.04	21.58
Ohio & Mississippi	114	...	385,655	3,383	....	.....	.....	.....	.....	.....	.....	....	3.76	2.99	0.24	1.09	5.50	1.39	14.97
Old Colony	...	220	567,598	2,580	....	.....	.....	.....	.....	60.55	.....	....	3.64	12.11	0.60	....	6.84	0.82	24.01
Philadelphia & Reading	...	...	1,789,650	......	....	....	.....	.....	.....	81.23	.....	....	3.64	4.60	0.32	....	5.74	0.38	14.68
Year ending Sept. 30, 1891.																			
Boston & Maine	...	...	12,908,812	......	....	.....	.....	.....	.....	50.26	.....	....	2.64	10.53	0.28	0.10	6.19	0.56	20.30

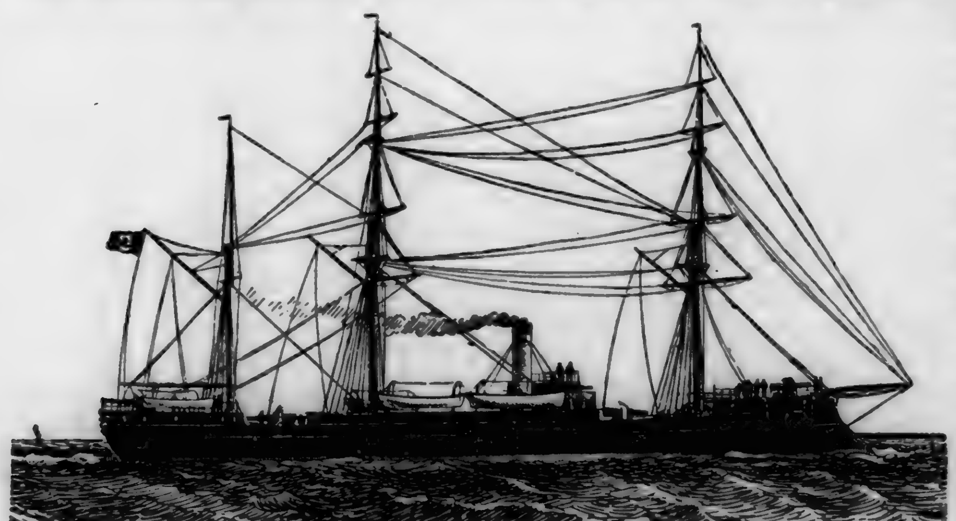
* Five empty cars rated as three loaded ones. † Average for engines in revenue service only. ‡ Two empty cars counted as one loaded car.

The armament of the ship is not heavy. It consists of two 6-in. guns, one mounted on the forecastle and the other on the poop, and of six 4.7 in. rapid-fire guns mounted in broadside. The secondary battery includes eight 6-pdr. Hotchkiss, one 3-pdr. Hotchkiss and four 5-barrel Nordenfelt guns. There are also four torpedo-tubes, one at the bow, one at the stern and two under the poop. This armament is about the same as will be carried by the new cruiser *Detroit*, which is only 2,000 tons displacement.

On the steam trial the engines of the *Thetis* developed 7,523 H.P. with natural draft, and 9,946 H.P. with forced draft, exceeding the contract power. The speed trials have not yet been made.

A MEXICAN CRUISER.

The accompanying illustration, from *Le Yacht*, shows the cruiser *Zaragoza*, recently completed at Graville, France, by the Forges et Chantiers de la Mediterranée. The *Zaragoza* is built for the Mexican Government, and is intended for a school-ship for its navy. The ship is 213.2 ft. long; 32.8 ft. beam; 18 ft. deep; 14.1 ft. mean draft, and 1,200 tons displacement. She is of steel, and the engines have worked up to 1,300 H.P. in the preliminary trials, giving a speed of 15 knots. She carries three masts and is bark rigged. The armament consists of four 12-cm. (4.72-in.) rifled guns, two 57-mm. (2.24-in.) rapid-fire guns, and two 37-mm. (1.46-in.) revolving cannon.



SCHOOL-SHIP FOR THE MEXICAN NAVY.

Manufactures.

The New Northern Pacific Shops.

The new shops of the Northern Pacific Railroad, at Edison, Wash., were formally opened, January 1. The plant covers 70 acres of land, and the floor space of the buildings aggregates 221,370 sq. ft. The dimensions of the various buildings are as follows: Coach repair shop, 100 × 243 ft., two stories high, the cabinet shop being located in the second story; machine shop, 120 × 244; wood working shop, 90 × 152; engine-house and steam-heating room, 42 × 74; paint shop, 90 × 242; paint-shop storehouse, 35 × 90, two stories; freight repair shop, 90 × 302; boiler, tank and copper shop, 80 × 321; engine house for machine shop, 40 × 40; office and storehouse, 43 × 156; blacksmith shop, 80 × 192; boiler iron storehouse, 25 × 50; coal and iron storehouse, 28 × 150; oil house, 43 × 60; two lavatories, 26 × 42 each; dry kiln, double, 40 × 72; dry lumber shed, 40 × 225. There are also two transfer tables, one 40 ft. in width and the other 70 ft., each having a range of travel of 325 ft. All the new machine tools for these works were furnished by Manning, Maxwell & Moore, New York. The roof trusses were supplied by the Union Bridge Company, of Athens, Pa. The machinery for collecting and removing shavings and sawdust from the woodworking shops was furnished by the Allington & Curtis Manufacturing Company, of Saginaw, Mich. The dry kiln apparatus is from the factory of the B. F. Sturtevant Company, of Boston. The oil-house tanks were built by Messrs. Kinney Brothers, of St. Paul. Messrs. Cofrode & Saylor, of Philadelphia, supplied the 10 small turntables which are used in connection with the system of transfer tracks extending through the buildings. J. A. Fay & Company

supplied much of the woodworking machinery. The Babcock & Wilcox Company furnished the six boilers, having an aggregate capacity of 624 H.P. The Industrial Works of Bay City, Mich., put in the electric cranes and transfer tables.—*Railway Age*.

The Fox Torpedo Placing Machine.

THE accompanying illustrations show a machine intended to place torpedoes upon the track, which appears to have many advantages in point of simplicity and effective working. It can be operated from a signal tower at the same distance that a semaphore signal can, and can also be arranged in such a way that it will be worked by the passage of the trains.

In the illustrations fig. 1 is a horizontal plan of the machine, showing the rail attachments, the crank and crank connections and the pipe or wire attachment; fig. 2 is a vertical plan of the magazine with the casing cut away; fig. 3 is a cross section through the line *x x*, fig. 1; fig. 4 is an enlarged plan of the projector; fig. 5 is a section on the line *a a*, fig. 4; fig. 6 shows an enlarged plan and two sections of the case *S*, fig. 1, in which the fulminate boxes are inserted; fig. 7 is a cross section of the supports and cover of the machine on the line *y y*, fig. 1; fig. 8 is a perspective view of the machine.

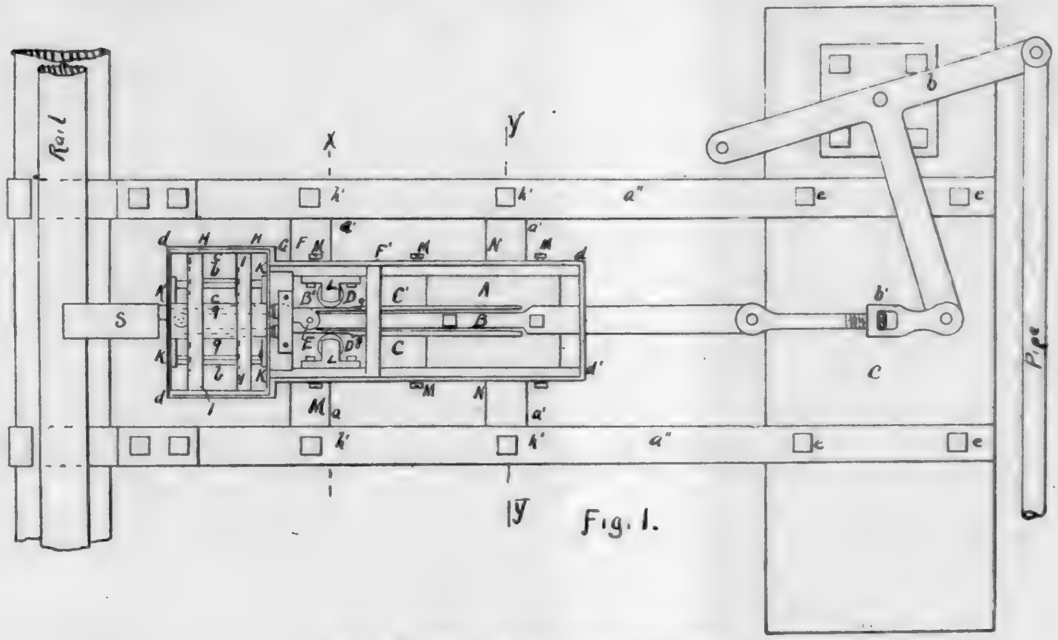
The magazine is of the simplest kind, and the principal parts as well as the magazine are made of steel and are very durable, the only precaution being an occasional coating of the working parts with plumbago or carburet of iron to prevent rust. The parts are all interchangeable and can be readily replaced in case of breakage.

The magazine or storage chamber shown in vertical section, fig. 2, with the casing cut away is 5 × 7½ in. inside sectional area by 16 in. total depth, and will hold 30 double torpedoes, which are fed with absolute certainty by the aid of the weights *o o* to the projector, which is contained in a horizontal box 16½ in. long, 5½ in. wide, and 3½ in. deep, firmly riveted to the magazine, and connected to a crank which is hooked up to either the pipe or the wire connections in the usual way.

The operation is by movement of the plunger or center bar *B*, fig. 1, in the direction of the rail, which carries with it the projector *c c*, which first enters the open end *e* of the tin case *S*, fig. 1, and *S* and *c*, fig. 6, three quarters of one inch; when the shoulders *g g*, figs. 1 and 4, passing between the rollers *D D*, fig. 1, cause the long arms of the projector to be pressed toward each other and with the stud *E* acting as a fulcrum spreads the jaws sufficiently to hold the tin case with a very firm grip, and with the continued motion of the plunger carries the said projector and tin case forward until the end of said tin case containing the fulminate rests from 1½ to 1¼ in. upon the rail, in which position it remains until the semaphore is thrown to "clear," when the projector and tin case are again brought back into the exact positions they first occupied before projection. If a train runs past the signal the explosion of the torpedo blows the tin case entirely off the projector; no part of the exploded case can possibly enter the magazine to clog it up.

The projector is made of the best spring steel, and notable in this connection is the fact that if always at danger it will not be liable to lose its elasticity, because the strain upon the neck is reduced to a minimum on account of the length of the arms from the shoulders *g g* to the point at which they rest between the rollers *D D* when at danger, which is three times the length of the jaws from fulcrum *E* to their extremity. The throw of the plunger is 7 in. and the distance from the end of the jaws (when at danger) to the rail is 3 in., which insures the projector from contact with the tread of the car wheels; outside of the spring properties of the projector there is not a spring of any kind used.

Referring to the various parts of the machine, which are indicated by letters in the different figures, fig. 1 is a horizontal plan of the machine, the central figure being the machine which is supported upon screw-threaded posts, which are secured to the iron cross-pieces *a' a' a' a'* bolted firmly to the iron hangers *a'' a''*, which are made to grip the foot of the rail, extending outward therefrom, rest upon and are securely bolted to the wood foundation *C*, which also has securely bolted to it the crank plate with crank and shackle *b* and *b'* attached and showing also the pipe (or wire) connection. In figs. 1 and 2 *d d* is the casing of the magazine in which is contained the torpedoes *Q*, one of which is shown at *S* projected on the rail. *K K* are guides between which the torpedoes are carried upward by the aid of flexible galvanized steel bands *P P*, which pass over the pulleys *I I* and revolve upon the axles *b b*, fig. 1, which are journaled into the guides *K* until they impinge against the



FOX'S TORPEDO PLACING MACHINE.

rollers *H H*, which are journaled into the bearings at *c c*. *R* is a wood platform upon which rest the torpedoes, and is supported by the steel bands; *O O* are cast iron weights suspended from the extremity of the bands.

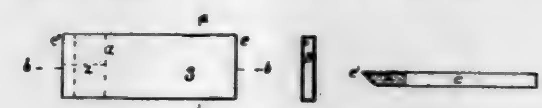


Fig. 6.

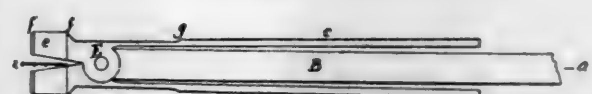


Fig 4

Fig. 5

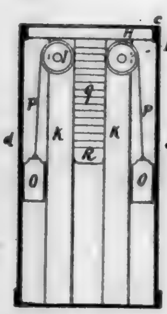


Fig 2.

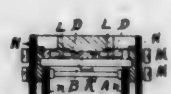


Fig 3

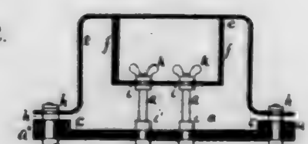


Fig 7

The guides *K* and the bearings *c c* are securely bolted to the casing *d d*, the holes for the bolts being slotted to secure easy adjustment of the parts; *d' d'* is the casing of the horizontal box, fig. 3, being a cross section through *X X*, and contains the

grooved slides *N N*, a cross-head *A* fitted to move freely in the groove of said slides, a plunger *B* securely bolted to the said cross-head, one end being reduced in breadth and having a stud *E* formed upon its extremity, to which are pivoted the two jaws *C C* of a projector *B'*, the two jaws of which are supported upon a slotted bearer *G* having a bridge *F* fitting loosely upon pins secured in the bearer, which prevent the jaws from spreading too much or jarring off the stud; a similar bridge at *F'* serves the same purpose, the long arms being supported upon the cross-head *A*, the sides of the projector being reduced at *g g* to give that portion free play between the rollers *D D* which are journaled in the ears *L L*; said ears being bolted to the slides *N N*. In fig. 3 *n n* are posts incorporated with the slides and extending to the bottom of the box, forming supports for the said slides. *R'*, fig. 3, is one of three double-ended screws passing loosely and having two nuts each, which impinge against the inside of said slides. *M M* are screws threaded into the casing of the box, all of which are for the purpose of adjusting the slides to the cross-head and compensating the wear of the latter.

Fig. 4 is an enlarged view of the projector and narrow stud end of the plunger, wherein *C C* are the two arms with their jaws; *B* is the plunger; *E'* the stud; *g g* the shoulders of reduced part; *e* is slightly reduced in thickness (to correspond with the thickness of tin from which the cases are made) from the line *f f* to the extremity, the under side being tapered from *f f* outward, the top and sides of the extremity being slightly beveled, as shown.

Fig. 5 is a section through *a a* of fig. 4, wherein *E'* is the stud, *f f* the shoulders, *c* and *c'* parts of the end and joint of the projector.

Fig. 6 is an enlarged view of the torpedo case *S*, fig. 1, wherein *S* is the case, having one end *e'* closed and chisel shaped, the other end *e* open; *B* is a cross section through *a a*, and *c* is a section through *b b* showing a section of the fulminate boxes at *d*. The position of the fulminate boxes in *S* is shown by broken lines *h h*. The object of the shouldered and tapered end *f f* of the projector, figs. 4 and 5, is to enable that position to easily enter and be flush at the upper and lower sides, the open end *e* of the tin case *S C*.

Fig. 7 is a cross section through *Y Y*, fig. 1, showing the manner of supporting the machine upon the cross pieces *a' a'*, wherein *a a* are screw-threaded posts, with nuts *i i* to secure

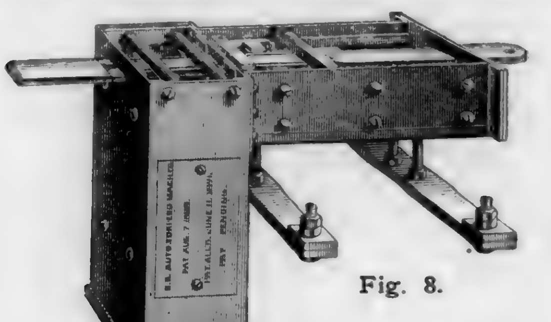


Fig. 8.

them to the cross-pieces *a'*, nuts *i' i'* upon which the horizontal box rests, and thumb nuts *k k* on the inside of and to secure the box to the posts; *f f* is the casing of the box, *e e* the cover; *d d* are bolts to secure the cross-pieces to the hangers *a''* by the nuts *h' h'*, the bolts *d d* being left long enough for the cover *e* to drop over and be secured by *h h*; one of these bolts being large enough to allow a hole through it which will admit the bow of a padlock. This manner of supporting the machine allows a ready adjustment to the height of rail.

The feed mechanism being a weight balance cannot fail to feed or press upward the cases; the top one impinging against the rollers *H*, is thus always kept in line with the cavities or slots in both sides of the magazine through which the projector and cases have to pass, as well as in perfect line for the jaws of the projector to enter. The power of the weights is sufficient at all times, whether one or 30 torpedoes are to be supported.

The magazine being made water-tight can never freeze up; the entire machine is so constructed that it is reliable under all atmospheric conditions.

The machine described has been in constant use on the New York Central & Hudson River Railroad in New York since July 13, 1891. It was at first connected with a switch signal operated from the Forty-ninth Street tower, and nine weeks later was moved to the most important signal station in the Fourth Avenue tunnel, that at Eighty-sixth Street, where it still remains. During this period no failure has been recorded against it, although over 200 torpedoes have been used. Competitive trials have shown that for simplicity, storage capacity, and certainty of feed and production and freedom from clogging, no fault can be found with the machine, and that it needs very little care or lubrication. It may be stated that on trial the machine has been worked by trains running from 10 to 40 miles an hour at a distance of 3,960 ft. around two sharp curves. In another experiment the machine was arranged to run continuously for 96 consecutive hours and placed 102 torpedoes each 24 hours without failure of any kind.

Baltimore Notes.

A CERTIFICATE incorporating the Baltimore & Cumberland Railroad Company has been filed with the Secretary of State at Annapolis. The company is incorporated under the general act of the State of Maryland, and names the following promoters of the enterprise: David L. Bartlett, John A. Hamilton, Bernard N. Baker, H. Irving Keyser, of Baltimore City; Buchanan Schley, of Hagerstown; Harry G. Davis and Thomas B. Davis, of West Virginia. The capital stock is fixed at $100,000, with authority to increase to $2,000,000 as the exigencies of the construction may require. The projected road is a continuation of the West Virginia Central Railroad, which is operated from Davis, W. Va., to Cumberland, Md., its present eastern terminus. The Baltimore & Cumberland will connect with the West Virginia Central at or near Cumberland, and will, it is said, be built to Baltimore, which will be its seaboard outlet. The line will pass through Allegheny, Washington, Frederick, Carroll and Baltimore counties. The incorporation of the road is the result of the failure of the promoters to get possession of the Chesapeake & Ohio Canal. The route as laid down is the same as that of the Western Maryland, and it is thought by many financial and railroad men that the control of the Western Maryland may be one of the intentions of the promoters. If that road is not secured the new line will parallel it between Hagerstown and Baltimore.

THE Baltimore & Ohio Company has contracted with the Baldwin Locomotive Works for the construction of 12 consolidation, five passenger, 10 switching and 13 ten-wheel engines.

A New Universal Wood-Worker.

THE accompanying illustration represents the latest improved wood worker, of the Egan pattern, which is designated as No. 2½, and is designed for heavy and light work, possessing all the advantages of the No. 1 and No. 2 machines, but of greater capacity. It will be found especially adapted to car work, agricultural work, general wood-working purposes, and for dressing and taking out of twist large timbers and planing a right angle at one operation. The main head is slotted on all four sides, and 19½ in. wide, and, running in connection with the four-sided upright head, makes a very desirable machine for general use, and gives the very best of satisfaction.

The column is one complete casting cored out, heavily braced, and with ample floor space, insuring steady running, free from vibration when the mandrels are running at high speed.

The tables are of extra width and length, planed perfectly true, and made with wide grooves to secure the gaining and paneling frames, and exactly at right angles to the cutter head. Either table can be raised and lowered independent of the other, or they can be raised and lowered together on a circle of the

EXTRA LARGE UNIVERSAL WOOD-WORKER.

head, or straight up and down. All of these adjustments are made from the working side of the machine close to the cutter head, which allows the operator to make the necessary adjustments without going to the end of the machine.

The mandrels are of the best quality of steel, running in self-oiling boxes lined with Babbitt metal. The main mandrel is of

larger diameter, with the pulley on same running between the two back bearings. The front bearing is adjustable, and can be taken off instantly when a change of heads is desired. This mandrel is also fitted up with patent adjustable bearings, by which the boxes, with mandrel and head, are moved back and forth across the bed as desired, instead of making the adjustments by means of the fence, which will be found a great advantage and a great saving in time.

The patent beveling fences are made to adjust across the tables, one fence placed over the main head, and one back of the upright head. Both are made with sliding plates; and, when beveled, the lower part is close to the tables and so constructed as to have no forward motion. It is also arranged to take in posts and springs for holding down the stock while being passed over the cutter head.

The boring attachment on the opposite side is perfectly independent in operation. Two men can work the machine at one and the same time without any interference. It is capable of doing all kinds of boring, routing, rosette-making, dove-tailing table slides, and a general run of this kind of work.

The machine is furnished complete for ordinary work, such as planing out of wind up to 19½ in. wide, squaring one edge up to 4 in. thick at the one operation, and also for surfacing straight or tapering, beveling, jointing, rabbeting, making glue joints, either concave or convex; also circular, straight and wave moldings, chamfering, routing, boring, as well as gaining, grooving, panel-raising, ripping, cross-cutting, rosette, cutting, etc., can be done to advantage on this machine.

For information in regard to this machine, application should be made to the Egan Company, Nos. 194–214 West Front Street, Cincinnati, O.

Signals.

The Long Island Railroad Company has recently put in operation a system of block signals on the section between Long Island City and Jamaica, where the traffic of the different branches of the road is concentrated. The blocks are somewhat less than a mile in length, there being 11 towers in a distance of 9 miles. The system in use is one which has been modified by the Company's own practice and arranged by its engineers.

Early in the month it was announced that the New York Central & Hudson River Railroad Company had made contracts for a system of block signals on the Sykes system to extend from Yonkers to Oscawana, near Sing Sing. From Sing Sing to Peekskill the Company has been testing the Hall system, and from Peekskill to Poughkeepsie a contract has also been let to the Johnson Signal Company for equipping the road with the Sykes system, the blocks being a little over two miles apart. From Poughkeepsie to Albany the Sykes system is also to be used, and bids have been asked for for the signals for that section.

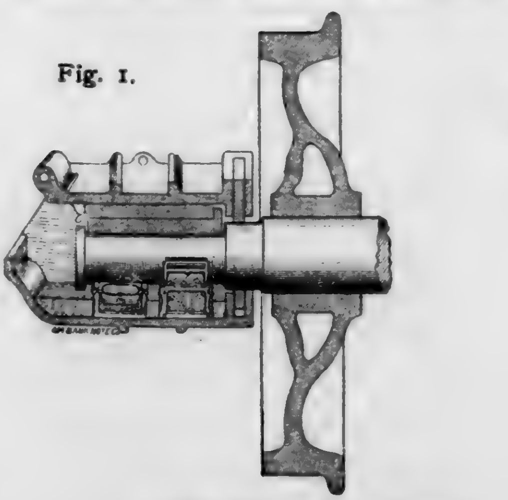
West of Albany nothing has yet been done; but it is stated that the directors have decided to adopt block signals for the entire distance to Buffalo.

The Nichol Lubricator.

The accompanying illustrations show the Nichol Gravity

Fig. 1.

Fig. 2.



THE NICHOL LUBRICATOR.

Lubricator, fig. 1 being a longitudinal section of a journal box provided with the device, and fig. 2 a cross-section.

It is a mechanical appliance for lubricating car journals, consisting of a frame, as shown in the cuts, by which a felt pad is held up against the journal. This pad draws up the oil from the bottom of the box, and thus keeps a constant supply on the surface of the journal. It is shown so completely in the drawings that little description is needed.

It is simple and durable in construction, the frame lasting indefinitely, unless injured by breaking of box or journal, and the felt lubricating pad will sustain several years' wear without renewal. No waste is required, it has no springs, is perfect in action, requiring the minimum of attention, and can be readily adapted to any form of box or journal.

The lubricator has been in constant use on several railroads for two years past in all temperatures. One Superintendent of Motive Power, on whose road it has been in use, writes of these lubricators that "they worked very satisfactorily in cold weather or hot, and I am satisfied that, with the care that is usually given to an oil-box packed with woollen waste, these lubricators are as good as two to one in favor of the lubricators."

The following test of the Nichol lubricator was made on the Central Railroad of New Jersey from July 17 to October 29, 1891. Four boxes of car No. 468 were lubricated with oil and packed with waste in the ordinary way, and the other four were provided with the Nichol lubricator. During the above period the car ran 18,759 miles. The following shows the oil, waste, etc., used:

FOUR BOXES PACKED WITH WASTE.	
6¾ lbs. woolen waste @ .06⅔	$0.45
37¾ qts. No. 2 oil @ .05	1.88
	$2.33
FOUR BOXES WITH NICHOL LUBRICATORS.	
8 new wicks @ .05	$0.40
16¾ qts. No. 2 oil @ .05	0.83
	$1.23
SUMMARY.	
Cost per 100 miles for oil and waste	1.24 ct.
" " 100 " " oil and wicks of lubricator	0.66 ct.

The cost of lubrication of car No. 494 with Nichol lubricators from April 30 to October 27, 1891, during which time the car ran 17,890 miles, was as follows:

18 new wicks @ .05	$0.90
33¾ qts. No. 3 oil @ .01¼	0.42
Total	$1.32
Cost of maintaining per 100 miles	0.74 ct.

In this case, two of the new wicks were required to replace two damaged by a defective brass.

These figures speak for themselves, showing remarkable results with even the cheapest grade of oil, and require no comment.

A Model Municipal Electric Lighting Station.

It is seldom that a central electric lighting station is so complete in its appointments that there is little or nothing to criticise or suggest.

After a thorough personal inspection of the different systems operated in the larger cities of the United States, the Allegheny City councils have incorporated all the points of advantage of each in their own, and have, in consequence, a very compact and efficient station.

It is essentially Westinghouse throughout, and consists of a series of independent units, any one of which may act as reserve without interfering with the operation of the others. This is probably the only plan of arrangement that would permit the concentration of so much power and capacity for lighting in so small a space.

In detail, the machinery consists of:

1. Three 13 and 22 × 13 Westinghouse compound engines, belted direct to three 1,500-light Westinghouse alternating current incandescent dynamos, of which two are in general use, while the third is alternately used as reserve.
2. Four 13 and 22 × 13 and one 10 and 18 × 10 Westinghouse compound engines, belted to nine 65-light Westinghouse alternating current arc dynamos, of which four units are sufficient for the service, and the fifth acts as relay.
3. Two 6½ × 6 Westinghouse standard engines, belted to two 100-light Westinghouse direct current dynamos for use as exciters of the field magnets of the alternating generators.

The engines are ranged in rows on each side of the room, and are belted to the dynamos in the center.

All this machinery, transmitting 1,000 H.P., and with a capacity for 4,500 incandescent and 540 arc lamps, occupies a floor space of but 56 × 57 ft. A 6-ton crane over the dynamos and a 2-ton traveler over each row of engines insures promptness in shifting or repairing.

In the boiler-room the same careful attention to details is shown. Six 100 H.P. Erie boilers, of which one acts as reserve, are fitted with Roney stokers, and the coal is loaded direct from the car into a tank traveling on an overhead rail, so hung as to empty the coal into the hoppers of the stokers.

Two pairs of duplex pumps and three injectors, either of which is sufficient for the purpose intended, are guarantees against accident to the feed-water supply.

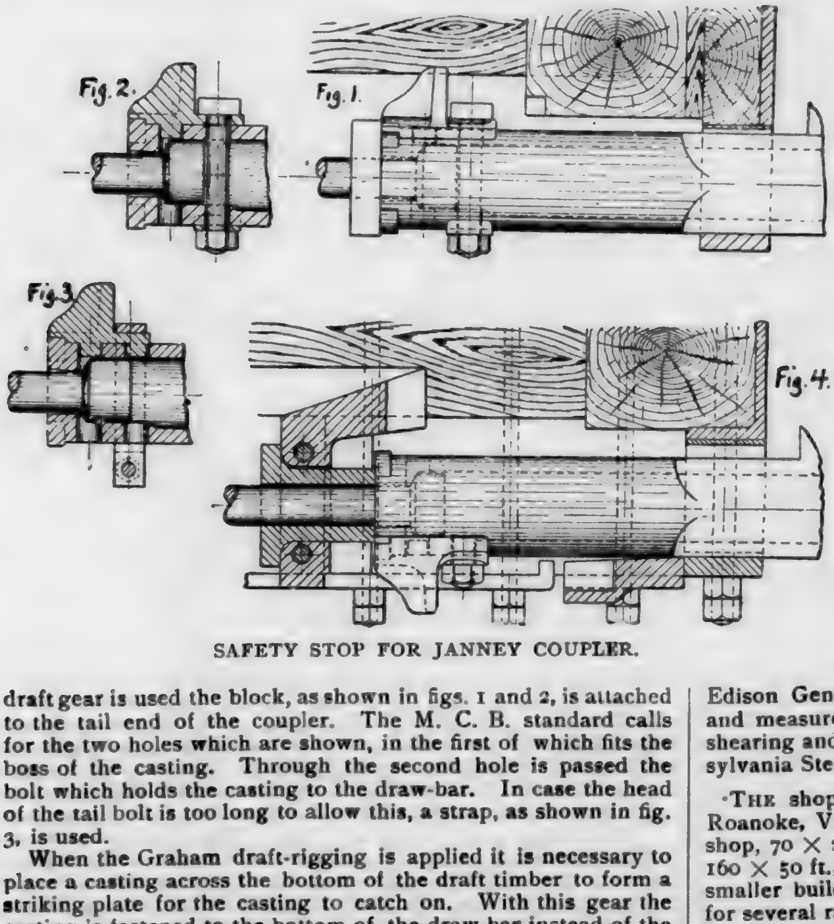
The stokers are operated by a $4\frac{1}{2} \times 4$ Westinghouse standard engine, whose motion is reduced through a screw gear, and a second engine duplicates the first, and is for use in case of accident.

The steam pipe is continuous, and any portion may be disconnected without interfering with the rest of the plant.

On the whole, this station is well designed, well lighted and well managed; and, with its interior finish of natural wood, always kept carefully clean, it presents an air of neatness in striking contrast to many larger and more pretentious stations.

Safety Stop for Janney Couplers.

THE accompanying drawings show a safety stop devised to prevent the trouble caused by the draw-bar pulling out when the continuous draft-rigging is used. Where the M. C. B.



SAFETY STOP FOR JANNEY COUPLER.

draft gear is used the block, as shown in figs. 1 and 2, is attached to the tail end of the coupler. The M. C. B. standard calls for the two holes which are shown, in the first of which fits the boss of the casting. Through the second hole is passed the bolt which holds the casting to the draw-bar. In case the head of the tail bolt is too long to allow this, a strap, as shown in fig. 3, is used.

When the Graham draft-rigging is applied it is necessary to place a casting across the bottom of the draft timber to form a striking plate for the casting to catch on. With this gear the casting is fastened to the bottom of the draw-bar instead of the top as in the other, being held in position by the small bolt. This arrangement is shown in fig. 4.

It can be readily seen that in case of the tail bolt breaking with either construction the casting will prevent the draw-bar being pulled out. The arrangement is devised by the McConway & Torley Company, and is furnished by that company with their couplers, without additional charge.

General Notes.

THE Westinghouse Air Brake Company has announced a reduction in the price of its quick-acting brakes for freight cars from $45 to $40 per set. The Company's increased facilities and improvements at Wilmerding have reduced cost of production.

IN consequence of confusion arising from similarity in names of competing heating companies, the Baker Heater Company has sold its business to William C. Baker, and all business will hereafter be transacted in his name. All orders will be filled by him, and the business will be carried on as heretofore, except that the same will be in the name of William C. Baker, who has no connection with any other concern bearing the name *Baker*. Mr. Baker's long experience and success in the heater business is well known.

THE Baldwin Locomotive Works, in Philadelphia, have lately completed a compound locomotive of the Vauclain four-cylinder type, which is to be submitted to careful tests under the charge of a committee of the Master Mechanics' Association. It is a ten-wheel engine, with six drivers 72 in. in diameter and a four-wheel truck with wheels $33\frac{1}{4}$ in. in diameter. The cylinders are 14 in. and 24 in. in diameter and 24 in. stroke. The driving-wheel base is 12 ft. 6 in., and the total wheel-base 24 ft. 2 in. The boiler is of the straight-top pattern, 62 in. in diameter, and has 270 tubes 2 in. in diameter and 14 ft. long; the working pressure will be 180 lbs. The fire-box is 10 ft. long and 34 in. wide inside. The weight is 133,000 lbs., of which 100,000 lbs. are on the drivers. The tender is carried on eight 36-in. wheels; the tank will hold 3,600 gallons of water.

THE Detroit Dry Dock Company, Detroit, Mich., has three steel and two wooden steamers under contract. The latest contract is for a steel passenger boat 165 ft. long, 35 ft. beam and 9 ft. 6 in. deep; the engines will be triple-expansion, with cylinders 16 in., 24 in. and 38 in. in diameter and 24 in. stroke, and the boat is expected to make 18 miles an hour.

THE Ferracute Machine Company, of Bridgeton, N. J., manufacture a great variety of presses, dies, and other sheet-metal tools. They have during the past two years built a number of heavy presses which are especially adapted for railroad work. Among others are a large line of double-column presses built from both heavy and light patterns, and both with and without gearing, which can be used to advantage in cutting out various large articles, in shearing, punching, flanging and punching rows of holes in sheets, etc. There is a considerable line of work in car and railroad shops, boiler shops, etc., where such machinery can be used to much better advantage than the old-fashioned single punches. They have recently much increased their plant. They also build a special line of punching and shearing presses with a fly-wheel at the back, which are of excellent design, very massive and strong in all their parts, and which can be used not only for shearing and punching, but for cutting out various parts in thick metals. Their machinery is fitted up with forged steel shafts, hardened bolts and nuts, and with a new form of automatic clutch and graduated adjustment for slide-bars or rams, and other improvements. They have also just introduced a new line of cutting presses for lighter metals which are very handsome in design and simple in their operation. Among other large presses recently built by them is an immense cutting press for the Edison General Electric Company, which weighs 21,000 lbs. and measures 100 in. between columns, also four very large shearing and punching presses with attachments for the Pennsylvania Steel Company.

THE shops of the American Bridge & Iron Company at Roanoke, Va., include a main shop, 210×75 ft.; a templet shop, 70×20 ft; a foundry, 125×50 ft. and a machine shop, 160×50 ft., besides the engine-house, storehouse and other smaller buildings. The Company now has contracts on hand for several railroad bridges, a number of highway bridges, and for all the ironwork of a new blast furnace.

AN ingot of nickel-steel weighing 95,000 lbs., to be used in the manufacture of armor-plates, was cast in the open-hearth department of the Bethlehem Iron Works, at South Bethlehem, recently. It was 47 in. thick and 90 in. wide, and the mold in which it was cast weighed 56 tons. The ingot will be forged into armor-plate, which will be used on the battle-ship *Maine*, now being built at the Brooklyn Navy Yard.

THE Pittsburgh Bridge Company has been awarded the contract for the iron and steel work on the new Union passenger station at St. Louis. The cost for this portion of the structure alone will be nearly $350,000. The depot roof will cover a space of 424,200 square feet, said to be the largest area ever covered for railroad terminal purposes under one roof in the world.

A RECENT notice in our columns stated that the Continental Iron Works, Brooklyn, N. Y., had made a large sale of their celebrated corrugated furnaces to J. T. Ryerson & Sons, through Messrs. Fraser & Chalmers, of Chicago. This, we are later

informed, is partly incorrect. The furnaces—there were eight of them—were for Messrs. Fraser & Chalmers, of Chicago, and the order was placed through Messrs. J. T. Ryerson & Sons, who are agents of the Continental Iron Works.

THE Phœnix Bridge Company, Phœnixville, Pa., is building two iron viaducts for the Elmira, Cortland & Northern Railroad, to replace old structures. One of them is 800 ft. long and 150 ft. high at the highest point; the other is 700 ft. long and 50 ft. high.

THE Baldwin Locomotive Works, Philadelphia, recently received an order for 20 locomotives for the Lehigh Valley Railroad, in addition to 20 which are now under construction.

THE Pittsburgh Locomotive Works are building 20 locomotives for the Manhattan Elevated Railroad in New York. They are Forney engines of the standard Manhattan type.

THE Pennsylvania Railroad Company's late order for new freight cars was distributed as follows: Michigan Car Company, Detroit, 750; Peninsular Car Company, Detroit, 750; Erie Car Works, Erie, Pa., 500; Buffalo Car Company, Buffalo, N. Y., 500; Barney & Smith Manufacturing Company, Dayton, O., 500; Murray, Dougal & Company, Milton, Pa., 500; Terre Haute Manufacturing Company, Terre Haute, Ind., 500; making 4,000 cars in all.

THE N. W. Talcott Axle Works, at Brightwood (Springfield) Mass., have recently added to their business the forging of anchors. A separate building 40 × 60 ft. is set apart for this work; it has seven forges and a steam hammer, and facilities for making the largest anchors, weighing 5,000 lbs. each. About six tons per week can be turned out. There are at present only two private establishments in the country where large anchors are made—the Talcott Works and a forge at Camden, Me.—although there are anchor plants in some of the navy yards. The Talcott Works are now turning out about four tons of anchors per week, in addition to all their other work.

THE Consolidated Car Heating Company, Albany, N. Y., furnished to railroad companies 13,459 steam couplers, 459 complete car equipments, and 162 locomotive equipments during the year 1891. The car equipments included 99 to the Old Colony, 175 to the Boston & Maine, 45 to the Canadian Pacific, 64 to the Concord & Montreal, and an average of 10 a month to the Wagner Palace Car Company. On January 1 the Consolidated Company had on hand to be filled orders for 130 complete car equipments. It is announced that the Wagner Company has adopted the improved commingler (McElroy) system as well as the Sewall Coupler.

THE Baldwin Locomotive Works in Philadelphia some time ago adopted the system of subdivided power, and substituted a number of quick-acting engines for those formerly used. They have now no less than 18 Westinghouse engines in use, most of them of the compound type.

THE St. Charles Car Company, St. Charles, Mo., has under construction four passenger coaches for the Des Moines & Northwestern; four circus cars for Ringland Brothers; 10 large caboose cars for the Wabash Railroad and 100 box cars for the Pocahontas Short Line. The shops are very busy on these and other orders, including a number of freight cars for the Missouri Pacific.

AN excellent example of the use of subdivided power is found in the new Spreckels refinery in Philadelphia. There are no less than 67 steam-engines in this plant, and 61 of these are Westinghouse engines of various sizes.

THE Marinette Iron Works, West Duluth, Minn., are building triple-expansion engines for a new boat now under construction by the American Steel Barge Company. The engines will have cylinders 20 in., 32 in., and 54 in. in diameter and 42 in. stroke. The propeller will be solid, 12 ft. 6 in. in diameter and 16 ft. pitch.

THE Iowa Iron Works, at Dubuque, Ia., which is to build Torpedo boat No. 2, has decided to put in the Thornycroft boilers of the same type as those in the *Cushing*, but somewhat larger. The engines of the new boat will be required to develop about 500 H.P. more than those of the *Cushing*, as the boat is somewhat larger.

THE firm of Nassau & Kuhn, conducting the Charles C. Phillips Company in Philadelphia, has been dissolved. Mr. James Nassau has bought the plant and business of the Phillips Company, and will continue the manufacture of varnishes and japans as heretofore. Mr. Henry J. Kuhn has associated himself with the Flood & Conklin Company in Newark, N. J., in the same business.

THE American Steel Wheel Company has purchased a large tract of land at the new station known as Garwood, on the Central Railroad of New Jersey, and purposes establishing there a large manufacturing town. A considerable part of the tract will be used for their own extensive works and the rest of it will be given over to other companies. It is understood that the Hall Signal Company has already made arrangements to establish its works on a part of the tract. The property purchased includes 300 acres, and is well located for the establishment of the town.

PERSONALS.

CLEMENT F. STREET, recently Chief Draftsman of the Chicago, Milwaukee & St. Paul Railway, is now Mechanical Editor of the *Railway Review*, of Chicago.

SAMUEL A. BEARDSLEY, of Utica, has been appointed a member of the New York Railroad Commission, in place of WILLIAM E. ROGERS, whose term has expired.

E. P. LORD has been appointed Superintendent of Motive Power of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, with office at Indianapolis, Ind. He succeeds F. P. BOATMAN, resigned.

CHIEF ENGINEER GEORGE W. MELVILLE, U. S. N., has been appointed Chief of the Bureau of Steam Engineering for a second term; a well-earned tribute to his successful administration of the Bureau during the past four years.

JOHN E. SANFORD, of Taunton, has been appointed a member of the Massachusetts Railroad Commission, to succeed GEORGE G. CROCKER. He is a lawyer and has been for three years past Chairman of the Harbor and Land Commission.

THE following promotions in the United States Engineer Corps are announced: MAJOR GARRETT J. LYDECKER to be Lieutenant-Colonel; CAPTAIN JOHN C. MALLOY to be Major; FIRST LIEUTENANT GEORGE W. GOTTHALS to be Captain; SECOND LIEUTENANT HENRY GERVEY to be First Lieutenant.

MAJOR H. D. BULKLEY, a well-known expert accountant, has been appointed Comptroller of the Baltimore & Ohio Company, appointment taking effect January 1, 1892. He will have the general supervision of the accounting of the several departments, and a special supervision of the accounting of the subsidiary companies.

HENRY E. WEISGERBER, formerly General Foreman of the Baltimore & Ohio shops at Wheeling, W. Va., has been appointed General Manager of the Wheeling & Elm Grove Railroad, a narrow-gauge road running from Wheeling to Elm Grove Park, a distance of seven miles. CHARLES HIRSCH is his successor as General Foreman of the Wheeling shops.

PROFESSOR LEWIS M. HAUPT, of the University of Pennsylvania, has been appointed a member of the Ship Canal Commission of Pennsylvania, succeeding the late JOHN M. GOODWIN. Professor Haupt's reputation as an engineer is well known, and he has made a special study of canals and waterways, making his appointment a most appropriate one.

GEORGE G. CROCKER has resigned his position as a member of the Railroad Commission of Massachusetts. His term expired a year ago, but he has remained in office, the Executive Council having refused to confirm Mr. Smith, who was nominated by the Governor to succeed him. Mr. Crocker has been an excellent and capable officer, and retires with a very good reputation.

W. J. DALE, JR., of Andover, has been appointed a member of the Massachusetts Railroad Commission to succeed E. W. KINSLEY, deceased. Mr. Dale is a farmer and merchant, and recently completed a term as Assistant Postmaster of Boston; he has an excellent reputation for intelligence and energy. His appointment was made under the law which requires one member of the Commission to be a business man.

THE President has made the following appointments of members of the Interstate Commerce Commission: WILLIAM R. MORRISON, of Illinois, whose term had expired, reappointed for another term; JAMES W. MCDILL, of Iowa, to succeed JUDGE THOMAS M. COOLEY, resigned; WILLIAM M. LINDSEY, of Kentucky, to succeed the late WALTER L. BRAGG. Mr. Lindsey is a lawyer and has served as a Judge of the Court of Appeals of his State. Mr. McDill is also a lawyer; he has been

on the bench and in Congress, and served two terms on the Iowa Railroad Commission.

OBITUARY.

A. G. DARWIN, who died at Glen Ridge, N. J., January 21, aged 64 years, was largely interested in the Strong Locomotive, the Lappin Brake Shoe, and several other manufacturing companies. He was well known among railroad men.

REAR-ADMIRAL C. R. P. RODGERS, who died in Washington, January 8, aged 72 years, had served continuously in the Navy since 1833. He served through the Mexican War, and during the late war took a prominent part in the operations of the Southern coast. He served one term as Chief of the Bureau of Yards and Docks, and also one term as Superintendent of the Naval Academy at Annapolis. He was retired in 1881. In 1885 he was appointed a delegate from the United States to the International Conference held in Washington to agree on a prime meridian, and was chosen to preside over the Conference.

WILLIAM F. TURREFF died in New York, January 18, after a short illness, of pneumonia. He was 57 years old. At an early age he began work as a machinist, and after a number of years spent on various Western lines he became Division Master Mechanic on the Cleveland, Columbus, Cincinnati & Indianapolis Railroad, and later Superintendent of Motive Power of the whole road. A few months ago he resigned that position to accept the office of Assistant Superintendent of Motive Power of the New York, Lake Erie & Western. Mr. Turreff was highly esteemed both personally and as a capable officer; he was widely known and had many friends.

ROSWELL B. MASON, who died in Chicago, January 2, aged 86 years, was born in New York, and commenced work as an assistant in one of the engineer corps on the Erie Canal. He was for several years connected with the Morris Canal, in New Jersey, and afterward was employed on the Housatonic, the New York & New Haven and the Vermont Valley Railroads. In 1851 he went to Illinois as Chief Engineer on the Illinois Central, and after the completion of that road was employed on some other railroad lines and on the Illinois & Michigan Canal. He was Mayor of Chicago at the time of the great fire, and the work done by him in that emergency is still remembered. He retired from business some years ago.

GENERAL MONTGOMERY C. MEIGS, who died in Washington, January 2 aged 75 years, was born in Augusta, Ga., and graduated from West Point in 1836. He was at first attached to an artillery regiment, but in 1837 was transferred to the Engineer Corps, in which he served 24 years. He was employed in the construction of several of the old forts on the seaboard and the lakes, and in 1852 was assigned to duty on the Washington Aqueduct, the survey and location of which was largely his work. He won a high reputation from his designs, which included the famous Rock Creek and Cabin John bridges. He was also for a time in charge of the extension of the Capitol, including the building of the great dome. When the war began, in 1861, he was appointed Quartermaster-General, and served in that capacity until 1878, when he was placed on the retired list, having reached the limit of age prescribed by law. His services in organizing the department and meeting the requirements made upon it, especially in the early part of the War, when the Army was increasing at an extraordinary rate, entitled him to a high place in the history of the period. After the War he visited Europe twice, in 1867 on a furlough for his health, and in 1875–76 on a special mission to study European army organizations. In 1876 he served on the commission appointed to report on the reorganization of the Army. Since his retirement he has had charge of the building of the Pension Office in Washington. General Meigs had a high reputation as an engineer and as a student of military science; he was a Regent of the Smithsonian Institution and a member of the National Academy of Sciences and of other scientific bodies.

EDWARD NICHOLS, President of the Brooks Locomotive Works, died in Dunkirk, N. Y., January 6, aged 41 years. The cause of his death was pneumonia, which resulted from exposure during the fire at the Locomotive Works on the night of January 31. Mr. Nichols was born in Middlebury, Vt., and graduated from the Rensselaer Polytechnic Institute, at Troy, in 1871. For a short time he was instructor in chemistry in the Institute, and afterward traveled for some time in Europe, studying and perfecting his knowledge of mining and metallurgical engineering. He was a member of the Reception Committee of the American Institute of Mining Engineers during the Centennial, in 1876, and was afterward for some time in the Bethlehem Iron Works and in the iron works at Lewistown, Pa. About 1879 he became associated with some gentlemen from Troy and Philadelphia in establishing a blast furnace in Northern Georgia. He was in charge of this for several years and also for a time served as State Geologist of Georgia. In 1883 he removed to Columbus, O., and was shortly afterward married to Miss Jessie Brooks, daughter of the late H. G. Brooks. His wife, however, died two years later, leaving her husband a young son.

In 1885 Mr. Nichols became Vice-President of the Warren-Scharf Asphalt Paving Company of New York, but two years later he gave up this position and was elected President of the Brooks Locomotive Works on the death of Mr. H. G. Brooks. Since then he has been at the head of the Works, and has shown himself conspicuously fitted for the position. He was highly esteemed by his friends and neighbors, and at their repeated solicitation served as Councilman from the Second Ward of Dunkirk, and took a prominent part in securing some important improvements in the city. He was also at the head of the Young Men's Building Association, and took a prominent part in many efforts for the public welfare.

Mr. Nichols' death will be deeply regretted by all who knew him, as well as his immediate associates, and his early death has cut short a life which promised to be one of the highest usefulness.

PROCEEDINGS OF SOCIETIES.

American Society of Naval Engineers.—The annual meeting was held at the Navy Department in Washington, December 22. The Secretary's report showed nearly 400 members.

Papers were read on Drainage for Ships, by Passed Assistant Engineer Worthington, and on Electric Light Appliances, by Passed Assistant Engineer G. W. Baird.

The following officers were elected for the ensuing year: President, Chief Engineer David Smith; Secretary and Treasurer, Passed Assistant Engineer Walter McFarland; Members of Council, Passed Assistant Engineers H. Webster, F. H. Bailey and W. F. Worthington.

New England Railroad Club.—At the regular meeting, in Boston, December 9, the subject for discussion was Tools for Railroad Shops; it was opened by Mr. E. E. Davis, who spoke of the advantages of special tools, and the waste and loss caused by keeping in use old tools, when better types had been devised for doing the same work. Other speakers generally agreed with these views.

American Society of Civil Engineers.—At the regular meeting of December 16 the Secretary announced the deaths of two members, John Lockwood and Colonel William E. Merrill.

A paper on the Red Rock Cantilever Bridge, by S. M. Rowe, S. W. Robinson and H. H. Quimby was read and briefly discussed.

AT the regular meeting in New York, January 6, there was a discussion on Mr. Waddell's paper on Disputed Points in Bridge Designing. Papers were read by Mr. R. B. Stanton on the Cañons of the Colorado River, and by Major A. F. Sears on Railroads in Peru. The discussion was on the availability of the cañons for railroad location.

The following elections were announced:

Members: James W. Deen, Salida, Col.; William M. Gordon, Albemarle, N. C.; Herbert F. Northrup, Traverse City, Mich.

Associate Members: Charles A. Cockroft, Syracuse, N. Y.; William H. Converse, Chattanooga, Tenn.; Alexander Potter, Rome, N. Y.; F. Rosenberg, Pueblo, Col.; Albert Smith, Washington, Pa.; Howard J. Cole, New York.

THE programme for the annual meeting stated that the meeting was to begin at 10 o'clock on Wednesday, January 20, at which session the annual reports were made, officers elected, reports of committees presented and discussed, time and place for the next Convention considered, general business transacted.

Lunch was served at the Society House at 13.30 o'clock, and the session resumed in the afternoon.

On the evening of Wednesday the meeting was continued. During the evening the Elevated Railroad in St. Louis was described by Mr. Robert Moore, and a description of the New Passenger Elevators and Iron Viaduct of the North Hudson

Company Railway, at Weehawken, N. J., was given by Messrs. George H. Blakeley and Mr. Thomas E. Brown, Jr. These descriptions were illustrated by the stereopticon.

On Thursday, January 21, there was an excursion. The points visited were: The New Passenger Elevators and Iron Viaduct of the North Hudson Company Railroad, by invitation of Mr. Charles B. Brush, Chief Engineer; Mr. Thomas E. Brown, Jr., Consulting Engineer, and Mr. George H. Blakeley, Engineer for the Contractors. To those who so desired time was given to visit the Reservoir and High Service Tower of the Hackensack Water-Works, also by invitation of Mr. Brush.

The party then proceeded by special steamer (lunch being served during this trip) to the Brooklyn Navy Yard where, by the courtesy of Captain Henry Erben, U. S. N., Commandant Navy Yard and Station, the following interesting work was inspected: The armored cruisers *Maine* and *Cincinnati*, now under construction; the new double-turreted armored ship *Miantonomah*; the machine and boiler shops, in which were found two pairs of marine engines building for the cruisers *Cincinnati* and *Raleigh*, and the Ordnance Shops.

In the evening a reception for gentlemen was held at the House of the Society, and at 21.30 o'clock supper was served.

The officers elected are: President, Mendes Cohen, Baltimore; Vice-Presidents (two years), Samuel Whinery, Charles B. Brush; (one year), Samuel M. Gray, John McLeod; Secretary, Francis Collingwood; Treasurer, John Bogart.

Iowa Civil Engineers and Surveyors' Society.—The annual meeting began in Burlington, Ia., December 29, with a good attendance. Correspondence from absent members and suggestions for work and legislative rules were read by the Secretary, Mr. Seth Dean, and President Tschirgi being unavoidably absent, his address was read by the Secretary.

Professor L. Higgins read a paper on needed changes in the laws relating to County Surveyors. Papers on Permanent Reference Marks, by C. W. Bisbee, and on Clay for Brick Making, by W. Steyh, were read and discussed.

On the second day the Report of the Executive Committee was read and approved. A very interesting paper was next read by G. Davis, C.E., on Iron. The paper was lengthy and explained quite fully the methods of manufacturing this metal for the different purposes for which it is used.

The Report of the Committee on Practical Work was an answer to the several questions that had been referred to them.

J. M. Brown, C.E., next read a paper on the cost of earthwork, giving an analysis of the elements entering into the problem under the different methods of handling, by both drag and wheel scrapers; also by wagons and by cars, with steam shovel for loading.

Papers were next read by the Secretary, as follows: Tide Lands of the Columbia River, by A. B. Little, C.E.; Trials of a County Surveyor, by D. O. Potter; Title by Adverse Possession, by Seth Dean; Calculating Overhaul, by R. G. Brown. Mr. Brown also furnished a supplemental article to his paper published last year on the Measurement of Earthwork; also an explanation of the principles of the "Kite" race track. Edward M. Gilchrist, C.E., furnished a paper on the subject of Relative Economy of Wood *vs.* Iron for Truss Bridges in Iowa. A discussion followed the reading of each of these papers which was quite generally participated in by the members present.

Amendments to the constitution were proposed changing the time of annual meeting to the third Wednesday in January; also that the Executive Committee take the necessary steps to have the Society legally incorporated.

The following named parties were elected for officers for the next year: President, William Steyh, C.E., Burlington; Vice-President, J. H. Cole, Keokuk; Secretary and Treasurer, Seth Dean, Glenwood; Directors, F. A. Macdonald and J. D. Wardle, Cedar Rapids.

The following named parties were appointed on the various committees:

Committee on Legislation, Professor L. Higgins; M. R. Laird, Des Moines; Edward M. Gilchrist, Keokuk.

Committee on Practical Work, J. S. Ratcliff, Waukon; W. L. Breckenridge, Burlington; J. M. Brown, Cedar Rapids.

A memorial to the Iowa members of Congress, asking in substance for their support of a measure transferring the work of internal improvements from the Secretary of War to the Secretary of Agriculture was passed.

The question of selecting the place for the next annual meeting was, on motion, left to be determined by a letter ballot.

After passing a vote of thanks to the city officers and the members of the Commercial Club and the citizens of Burlington for favors shown them, the Convention adjourned, thus closing the best and most interesting session the Society has ever held.

After adjournment an excursion to various places of interest was enjoyed by many of the members.

Michigan Engineering Society.—The thirteenth annual convention was to be held in Grand Rapids, January 19, 20 and 21. The programme included papers by members as follows: George S. Pierson, A Method of Sewage Disposal; J. H. Forster, Hydrographic Surveying; A. L. Reed, Development of Water-Bearing Strata, for Irrigation; S. E. Jarvis, Pneumatic Street Railway Propulsion; Professor W. H. Pettee, Building Stones of Michigan; A Recent Decision of the Supreme Court of the United States on the Ownership of Lake Beds; E. H. Mumford, Notes in a Rolling Mill; E. W. Muenscher, Easement Curves, and numerous others. A large attendance was expected, and careful arrangements had been made for the meeting.

American Forestry Association.—At the annual meeting which was held in Washington, December 29 and 30, the Secretary's report showed progress in the work. The chief effort of the year has been to secure the reservation of portions of the public timber lands under the act passed by the last Congress, and the Association has succeeded in having several reservations already made, and examination is now being made of other tracts.

The report of the Executive Committee, which was read by Professor B. E. Fernow, called attention to the growing needs for forest reservations, and stated that the necessity of preserving as well as setting aside those reservations has been recognized. A bill has been prepared to be submitted to Congress providing for the division in the general land office with a competent chief and assistants and a force of superintendents and forest rangers to prevent encroachments.

The Association approved these reports, and adopted a memorial to the President and Congress in favor of carrying out the recommendations.

The following officers were elected for the ensuing year: President, William Alvord, San Francisco; Recording Secretary, Dr. N. H. Eggleston, Washington; Corresponding Secretary, Edward A. Bowers, Washington; Treasurer, Dr. Henry N. Fisher, Philadelphia; Executive Committee, Professor B. E. Fernow, General J. Grant Wilson, Colonel E. T. Ensign, H. B. Ayres, Warren Higby and Henry Pellew.

Boston Society of Civil Engineers.—At the regular meeting in Boston, January 18, the subject for discussion was Government in Large Cities. It was opened by President F. P. Stearns by a brief address, and papers were then read on the Methods of Municipal Government in various cities as follows: Philadelphia, Professor Dwight Porter; St. Louis, Mr. Robert Moore; Boston, City Engineer William Jackson; New York, Francis M. Scott; Providence, City Engineer J. H. Shedd; Buffalo, E. B. Guthrie. The list was concluded by a paper on the Municipal Government of Paris by Mr. H. D. Woods.

New England Water-Works Association.—The Association held a regular meeting at Young's Hotel, Boston, on January 13, with about 75 members and visitors present. The usual dinner was followed by a business meeting at 2.30 o'clock, with President H. G. Holden in the chair and W. H. Richards Acting-Secretary. A letter was read from W. M. Hawes, Water Commissioner of Fall River, Mass., conveying his thanks and expressing his appreciation of the Christmas remembrance sent him by the Association as a token of esteem.

The President then introduced Reuben Shirreffs, Second-Assistant Engineer of the East Jersey Water Company, who read a paper describing the works of the East Jersey Water Company for supplying the city of Newark, N. J. This paper was illustrated with lantern views, showing the different features of the dams, riveted pipe line, etc., and was afterward informally discussed by Desmond FitzGerald, H. G. Holden, and others.

The following members were elected: *Resident, active:* Frederic I. Winslow, Boston; G. O. Sanders, Hudson, N. H.; John F. Springfield, Rochester, N. H.

Associate: George K. Paul, Boston.

Engineers' Club of Cincinnati.—The fourth annual meeting was held December 18. Messrs. Charles E. Lindsay, H. H. Hankens, Charles F. Koch and James A. Stewart were elected members.

Resolutions on the death of Colonel W. E. Merrill, who was one of the founders of the Club and its first President, were adopted. The Secretary presented his report showing 105 members, an increase of 9 during the year. The Treasurer's report was also submitted.

The following officers were elected for 1892: President, Samuel Whinery; Vice-President, Latham Anderson; Secretary and Treasurer, J. F. Wilson; Directors, W. B. Ruggles, H. J. Stanley, E. A. Hill.

The retiring President read a very interesting report giving a general résumé of Engineering progress in 1891.

Engineers' Club of Philadelphia.—At the annual meeting in Philadelphia, January 16, Mr. Wilfred Lewis, the President, delivered his annual address, referring to the growth and prosperity of the Club during the past year.

It was reported that the total number of members was 421. There had been a large increase in attendance at meetings and in the number of papers presented for reading.

The officers chosen for the following year were: President, James Christie; Vice-Presidents, Frederick H. Lewis and Pedro G. Salom; Secretary, John C. Trautwine, Jr.; Treasurer, T. Carpenter Smith; Directors, John E. Codman, George V. Cresson, Strickland L. Kneass, Wilfred Lewis, H. W. Spangler, David Townsend.

Engineering Association of the South.—The regular meeting, December 12, was held in the new rooms in Nashville, Tenn., for the first time. Several applications for membership were received. The Secretary presented the specifications governing the competition for the cash prize of $1 000 offered by the Board of Public Works of Duluth, Minn., for the best plans for a draw-bridge across the ship canal at that place.

Professor Olin H. Landreth brought up for consideration the question of instituting, under the auspices of the Association, a competitive trial of machinery used in highway building—such as graders, ditchers, surfacers, rock-crushers, steam and horse rollers, etc. After an extended discussion by Messrs. E. C. Lewis, Hunter McDonald and W. H. Lyle, which in the main was favorable to the enterprise, a committee was appointed by the Chair to investigate and report at the next regular meeting the feasibility of instituting the competitive trial proposed. Messrs. Olin H. Landreth, W. G. Kirkpatrick and J. A. Fairleigh comprised the committee.

Montana Society of Civil Engineers.—The annual meeting was held in Helena, Mont., January 9. The retiring President, Mr. E. H. Wilson, delivered his annual address. Reports were presented on Improvements to the Public Surveys and on the Engineering Congress at the Columbian Exposition.

The reports of the Secretary and Treasurer were read, and showed that the Society is financially in a prosperous condition. The election of officers resulted as follows: President, Colonel Walter W. De Dacey, of Helena; First Vice-President, Albert B. Knight, of Butte; Second Vice-President, J. S. Keerl, of Helena; Secretary and Librarian, F. D. Jones, of Helena; Treasurer, A. S. Hovey, of Helena; Trustee, Elliott H. Wilson, of Butte.

The meeting was concluded by a banquet in the evening.

Engineers' Club of St. Louis.—At the annual meeting, December 2, the reports showed a total of 136 resident and 45 non-resident members and 1 honorary member. There were 19 meetings held last year, at which 20 papers were read; a number of papers are already promised for 1892. The expenses were $1,554.

The officers for 1892 are: President, I. B. Johnson; Vice-President, B. L. Crosby; Secretary, Arthur Thatcher; Treasurer, C. W. Melcher; Librarian, R. E. McMath; Directors, George Burnett and B. H. Colby.

Civil Engineers' Society of St. Paul.—The annual meeting was held in St. Paul, January 4. Mr. Alfred Jackson was elected a member.

The following officers were elected for 1892: President, E. E. Woodman; Vice-President, J. D. Estabrook; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. Münster; Representative in Board of Managers of Association of Engineering Societies, C. J. A. Morris.

Western Society of Engineers.—The twenty-third annual meeting was held January 6, in the Sherman House, Chicago. Of the 206 votes cast for President—partly by letter—Isham Randolph received 100; J. F. Wallace, 84, and L. P. Morehouse, 22. President L. E. Cooley decided that Mr. Randolph had received a majority of the votes properly cast, but this decision was overruled on an appeal. Accordingly, the President will be chosen at the February meeting, Mr. Cooley holding over until then. The officers chosen were: First Vice-President, E. C. Carter, Chicago; Second Vice-President, Professor Ira O. Baker, Champaign, Ill.; Secretary and Treasurer, John W. Weston (re-elected); one Trustee, Charles L. Stroble. The membership is now 405, an increase of 67 during the year. After the election a dinner was served and speech-making was indulged in.

New York Railroad Club.—At the regular meeting, December 17, 15 new members were elected.

A paper was read by Mr. W. G. Berg, Principal Assistant Engineer, Lehigh Valley Railroad, on Coaling Stations for Locomotives. Mr. Berg was followed by Mr. H. A. Ainsworth, who described the Clifton chute. There was a brief discussion, during which a letter from Mr. A. J. Swift, Chief Engineer, Delaware & Hudson Canal, was read, speaking very highly of the Clifton chute in service on that road.

Mr. Ennis, Master Mechanic, New York, Susquehanna & Western, brought up the question as to whether or not there should be a labor charge made for putting on a brake-shoe or putting in a brass on a foreign car. The following resolution was adopted: That there should be no labor charge made for putting on a brake-shoe or putting in a brass in a foreign car, and that a modification to this effect should be made in Rule 8 of the interchange rules. It was also voted that other railroad clubs should be notified of this action of the New York Railroad Club

Texas Railroad Club.—This Club was organized at Fort Worth, Tex., November 16, when the following officers were chosen: President, John F. White; Vice-President, A. S. Douglas; Treasurer, Robert E. Masters; Secretary, Thomas A. Kuntz; Directors, W. P. Siddons, William O'Herin, Thomas Inglis, J. J. Ryan and James McGee. The Secretary's address is at Fort Worth, Tex.

American Society of Mechanical Engineers.—The Secretary has issued a pamphlet giving a full account of the meeting to be held in San Francisco in May next, and of the excursions proposed in connection with that meeting. From this members who desire to attend can ascertain the expense of the trip, how much ground they will be able to cover, with many other interesting points.

NOTES AND NEWS.

Aluminium.—Professor J. W. Langley has prepared an alloy of aluminium and titanium, which is as hard as the hardest steel, but has a specific very little above that of pure aluminium. The proportion of titanium in the alloy is somewhat less than 10 per cent.; a larger proportion was found to make the metal too brittle. The Pittsburgh Reduction Company is now making this alloy.

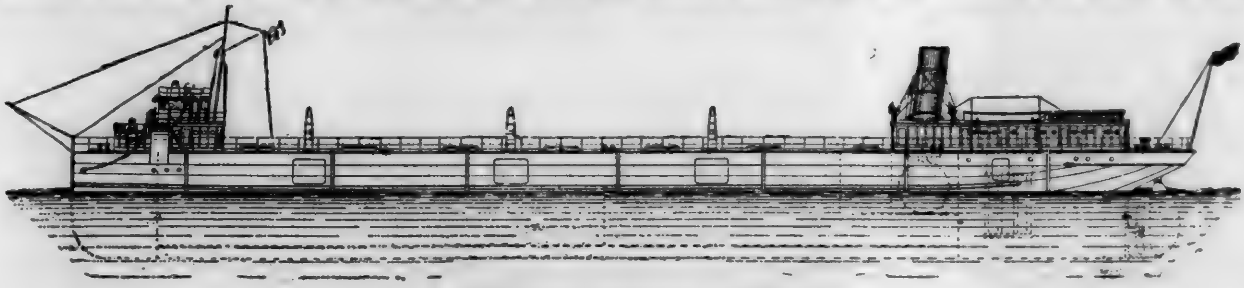
A life-boat of aluminium has been made at Stralsund, Germany, and some experiments with it will be made by the German Navy. Its lightness is a great advantage, if its other qualities prove good.

Steam Pipes.—Exposed pipes are great consumers of heat. Some time ago it was calculated that a foot of 2-in. pipe carrying 60-lbs. steam pressure left uncovered cost a dollar a year, and the figure is not far out of the way. It is better economy to get a good covering for steam pipes than to burn coal to make up the loss in heat.

Ventilation of Railroad Tunnels.—An ingenious method of extracting the foul air and products of combustion from underground railroads—or, rather, of preventing their entry into the tunnels—has been devised by Mr. Chris Anderson, of Leeds, and tried recently on a portion of the Metropolitan Railroad. The object in view is effected by making a connection between the smoke-box of the moving locomotive and a stationary flue connected with exhausting apparatus. To this end a rectangular tube, having at intervals valves opening downward on its top side, is fixed between the rails. One end of this tube as now laid is closed, while the other end, half a mile away, is connected with a Root's blower driven by a small engine. The locomotive, which is one of the company's ordinary passenger engines, is fitted with a long sliding box, which is open on the underside and is carried beneath the engine. This slider is connected at its front end by a down chimney with the smoke-box of the engine. There is a valve in this chimney, and another in the ordinary funnel of the engine, both being worked by a hand lever, and being so arranged that on opening one the driver closes the other. Thus, when the train is in the tunnel the products of combustion can be directed into the tube, and when in the open they can be allowed to pass through the funnel into the air. The slider glides freely on the top of the rectangular tube, and it has a rib running centrally its whole length, which, as it passes over each valve, presses down a projection on it and opens it. The distances between the valves and the length of the central rib of the slider are so relatively proportioned that a valve is always open to admit the products of combustion to the tube.—*Practical Engineer, London.*

An African Tunnel.—The Laing's Nek Tunnel, on the extension of the Natal Railroad, in South Africa, has lately been completed. It is 2,300 ft. long, and was cut chiefly through a hard blue shale, with occasional veins of harder rock.

New Lake Freight Steamers.—It is announced that the Anchor Line has let contracts for three new freight steamers, which will carry 2,700 tons each on 15½ ft. draft. They will cost about $178,000 each, and will be built respectively by the Union Dry Dock Company at Buffalo, the Globe Iron Works at Cleveland and the Detroit Dry Dock Company at Detroit.



A NEW LAKE FREIGHT STEAMER.

The general plan is shown in the accompanying sketch, from the *Marine Review*.

A new feature in the boats, which are to be duplicates in all respects, with the exception of probably a slight difference in the proportion of engines, is the absence of sheer in their construction. They will be built without any sheer—that is, they will be the same depth at ends as in the middle, and the gunwale will be a bevel line. In this there is said to be a saving of $12,000 to $15,000 on boats of this class. The boats are to be 275 ft. keel, 40 ft. beam and 26 ft. depth from base line to top of spar deck beams at side. The boats to be built by the Globe Company, of Cleveland, and the Detroit Dry Dock Company, will be engined by those companies; but H. G. Trout & Company, of Buffalo, will build the engines for the steamer to be built by the Union Dry Dock Company, and the Lake Erie Boiler Works, also of Buffalo, will build the boilers. The engines to be built by Trout will be 20, 33 and 54 in. × 45 in. stroke. The two boilers will be 12 ft. long and 14 ft. diameter, to be allowed 160 lbs. of steam. The boats will have steam capstans, windlasses, steerers and line shafting for hoisting purposes, together with electric lighting plants and all modern arrangements for rapid work in port.

The Marent Gulch Viaduct.—An interesting paper, recently read before the American Society of Civil Engineers by Mr. George S. Morison, describes this viaduct, which was designed by him, and which was built to replace a wooden structure. The change was made because it was not considered safe in the dry climate of Montana to retain so important a bridge in wood, where it was liable at any time to be destroyed by fire and to interrupt seriously the traffic of the road.

THE MARENT GULCH VIADUCT.

The general plan is shown in the accompanying illustration. The viaduct consists of five spans, each 116 ft. 8 in. long, two towers, each measuring 23 ft. 4 in. on top, and four girder spans of 30 ft. each, making the total length of the structure 796 ft. 8 in. The total height from the top of the masonry to the top of the stringer at the highest side of the central tower is 201 ft. 9 in. The viaduct is straight, but is built on a grade of 1.96 per cent.

The substructure consists of two small abutments and 24 small piers. They are generally founded upon rock, but in two instances were founded on clay and gravel, the area of the foundations being increased, and in two other cases piles were driven through clay until hard material was reached.

The towers were made of the same length on the top as the panel in the spans between them, in order to make the floor system uniform; in the direction of the bridge the batter was 1 in 48, while the side batter was 1 in 6, which made the high towers 31 ft. 3 in. × 83 ft. 2 in. at the base. The spans are deck truss, pin connected. There is a complete iron floor, the floor-beams resting on top of the chords and the stringers on top of the floor-beams. The wooden floor is laid on the stringers. The total weight of material in the structure was 1,673,039 lbs., of which 868,351 lbs. were in the towers, the balance in the substructure and flooring. The iron work was furnished by the Union Bridge Company, with the exception of a number of eye-bars, which were made by the Passaic Rolling Mill Company. The total cost of the bridge was $153,362.

A Japanese Mountain Railroad.—A new mountain railroad, to connect Karuisawa with Yokohama, is under construction over the Usui Mountain in Japan. The road is 7.3 miles long, and has 21 tunnels, the total length of which is 12,200 ft. The heaviest grades are 352 ft. to the mile, and the line will be worked on the Abt rack-rail system.

A Swedish Railway Project One Hundred Years Ago.—Close upon 40 years before Stephenson's victory, a Swedish engineer, Karl Hogstrom by name, not only constructed a locomotive on similar lines to the one of Trevithick and Vivian, but also conceived a plan of a regular railroad. His first notion was that his locomotive should be used on ordinary roads, but soon realizing the insurmountable difficulties attending this style of locomotion, he, in the year 1791, brought out his railroad scheme. The rails were to be of cast iron and perfectly smooth, and in order to prevent derailment the wheels were to have a projecting edge. Convinced of the insufficiency of friction between the smooth wheels and rails for the propelling of heavy trains, Hogstrom proposed that a toothed wheel on his locomotive should work on a central toothed bar or rail placed between the other rails—a plan which of late has been adopted in several instances where the gradient has been exceptional. Hogstrom's plan was laid before several scientists, who were unanimous in denouncing it as utter madness, as it was absurd to imagine that a carriage could ever be propelled by steam alone. The plan was entirely shelved, and nothing more appears to be known as to the fate of Hogstrom, who afterward went abroad.—*London Engineering.*

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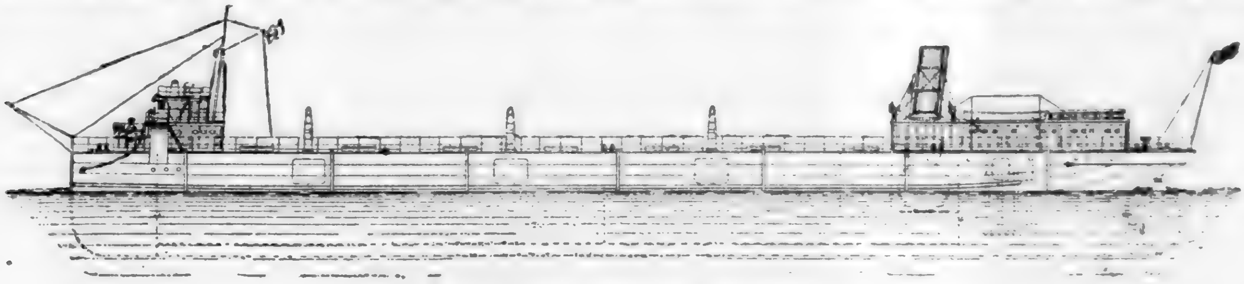
A life-boat of aluminium has been made at Stralsund, Germany, and some experiments with it will be made by the German Navy. Its lightness is a great advantage, if its other qualities prove good.

Steam Pipes.—Exposed pipes are great consumers of heat. Some time ago it was calculated that a foot of 2-in. pipe carrying 60-lbs. steam pressure left uncovered cost a dollar a year, and the figure is not far out of the way. It is better economy to get a good covering for steam pipes than to burn coal to make up the loss in heat.

Ventilation of Railroad Tunnels.—An ingenious method of extracting the foul air and products of combustion from underground railroads—or, rather, of preventing their entry into the tunnels—has been devised by Mr. Chris Anderson, of Leeds, and tried recently on a portion of the Metropolitan Railroad. The object in view is effected by making a connection between the smoke-box of the moving locomotive and a stationary flue connected with exhausting apparatus. To this end a rectangular tube, having at intervals valves opening downward on its top side, is fixed between the rails. One end of this tube as now laid is closed, while the other end, half a mile away, is connected with a Root's blower driven by a small engine. The locomotive, which is one of the company's ordinary passenger engines, is fitted with a long sliding box, which is open on the underside and is carried beneath the engine. This slider is connected at its front end by a down chimney with the smoke-box of the engine. There is a valve in this chimney, and another in the ordinary funnel of the engine, both being worked by a hand lever, and being so arranged that on opening one the driver closes the other. Thus, when the train is in the tunnel the products of combustion can be directed into the tube, and when in the open they can be allowed to pass through the funnel into the air. The slider glides freely on the top of the rectangular tube, and it has a rib running centrally its whole length, which, as it passes over each valve, presses down a projection on it and opens it. The distances between the valves and the length of the central rib of the slider are so relatively proportioned that a valve is always open to admit the products of combustion to the tube.—*Practical Engineer, London.*

An African Tunnel.—The Laing's Nek Tunnel, on the extension of the Natal Railroad, in South Africa, has lately been completed. It is 2,300 ft. long, and was cut chiefly through a hard blue shale, with occasional veins of harder rock.

New Lake Freight Steamers.—It is announced that the Anchor Line has let contracts for three new freight steamers, which will carry 2,700 tons each on 15½ ft. draft. They will cost about $178,000 each, and will be built respectively by the Union Dry Dock Company at Buffalo, the Globe Iron Works at Cleveland and the Detroit Dry Dock Company at Detroit.

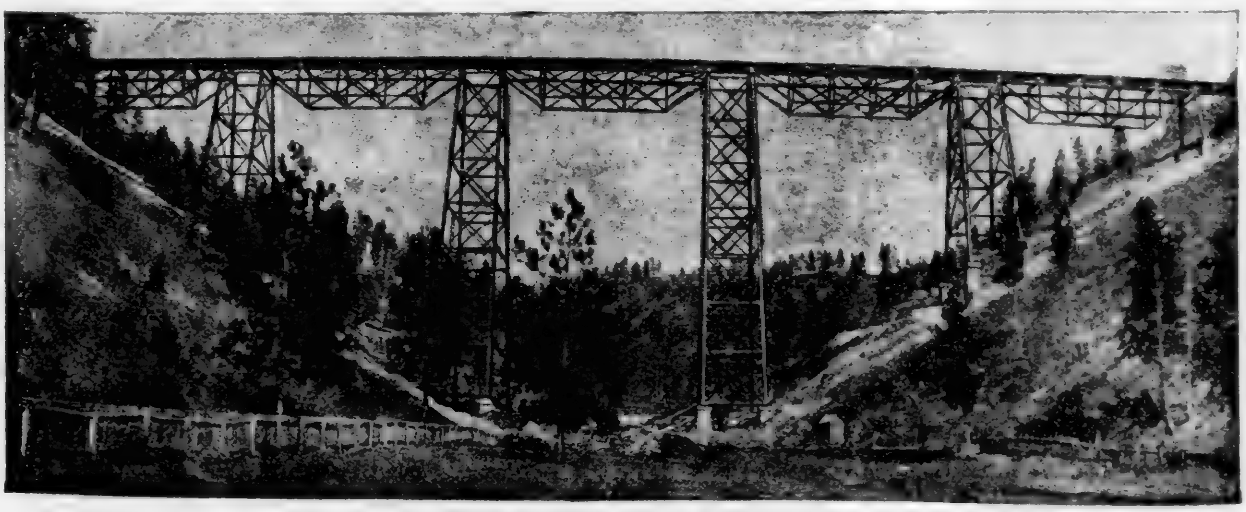


A NEW LAKE FREIGHT STEAMER.

The general plan is shown in the accompanying sketch, from the *Marine Review*.

A new feature in the boats, which are to be duplicates in all respects, with the exception of probably a slight difference in the proportion of engines, is the absence of sheer in their construction. They will be built without any sheer—that is, they will be the same depth at ends as in the middle, and the gunwale will be a bevel line. In this there is said to be a saving of $12,000 to $15,000 on boats of this class. The boats are to be 275 ft. keel, 40 ft. beam and 26 ft. depth from base line to top of spar deck beams at side. The boats to be built by the Globe Company, of Cleveland, and the Detroit Dry Dock Company, will be engined by those companies; but H. G. Trout & Company, of Buffalo, will build the engines for the steamer to be built by the Union Dry Dock Company, and the Lake Erie Boiler Works, also of Buffalo, will build the boilers. The engines to be built by Trout will be 20, 33 and 54 in. × 45 in. stroke. The two boilers will be 12 ft. long and 14 ft. diameter, to be allowed 160 lbs. of steam. The boats will have steam capstans, windlasses, steerers and line shafting for hoisting purposes, together with electric lighting plants and all modern arrangements for rapid work in port.

The Marent Gulch Viaduct.—An interesting paper, recently read before the American Society of Civil Engineers by Mr. George S. Morison, describes this viaduct, which was designed by him, and which was built to replace a wooden structure. The change was made because it was not considered safe in the dry climate of Montana to retain so important a bridge in wood, where it was liable at any time to be destroyed by fire and to interrupt seriously the traffic of the road.



THE MARENT GULCH VIADUCT.

The general plan is shown in the accompanying illustration. The viaduct consists of five spans, each 116 ft. 8 in. long, two towers, each measuring 23 ft. 4 in. on top, and four girder spans of 30 ft. each, making the total length of the structure 796 ft. 8 in. The total height from the top of the masonry to the top of the stringer at the highest side of the central tower is 201 ft. 9 in. The viaduct is straight, but is built on a grade of 1.96 per cent.

The substructure consists of two small abutments and 24 small piers. They are generally founded upon rock, but in two instances were founded on clay and gravel, the area of the foundations being increased, and in two other cases piles were driven through clay until hard material was reached.

The towers were made of the same length on the top as the panel in the spans between them, in order to make the floor system uniform; in the direction of the bridge the batter was 1 in 48, while the side batter was 1 in 6, which made the high towers 31 ft. 3 in. × 83 ft. 2 in. at the base. The spans are deck truss, pin connected. There is a complete iron floor, the floor-beams resting on top of the chords and the stringers on top of the floor-beams. The wooden floor is laid on the stringers. The total weight of material in the structure was 1,673,039 lbs., of which 868,351 lbs. were in the towers, the balance in the substructure and flooring. The iron work was furnished by the Union Bridge Company, with the exception of a number of eye-bars, which were made by the Passaic Rolling Mill Company. The total cost of the bridge was $153,362.

A Japanese Mountain Railroad.—A new mountain railroad, to connect Karuisawa with Yokohama, is under construction over the Usui Mountain in Japan. The road is 7.3 miles long, and has 21 tunnels, the total length of which is 12,200 ft. The heaviest grades are 352 ft. to the mile, and the line will be worked on the Abt rack-rail system.

A Swedish Railway Project One Hundred Years Ago.—Close upon 40 years before Stephenson's victory, a Swedish engineer, Karl Hogstrom by name, not only constructed a locomotive on similar lines to the one of Trevithick and Vivian, but also conceived a plan of a regular railroad. His first notion was that his locomotive should be used on ordinary roads, but soon realizing the insurmountable difficulties attending this style of locomotion, he, in the year 1791, brought out his railroad scheme. The rails were to be of cast iron and perfectly smooth, and in order to prevent derailment the wheels were to have a projecting edge. Convinced of the insufficiency of friction between the smooth wheels and rails for the propelling of heavy trains, Hogstrom proposed that a toothed wheel on his locomotive should work on a central toothed bar or rail placed between the other rails—a plan which of late has been adopted in several instances where the gradient has been exceptional. Hogstrom's plan was laid before several scientists, who were unanimous in denouncing it as utter madness, as it was absurd to imagine that a carriage could ever be propelled by steam alone. The plan was entirely shelved, and nothing more appears to be known as to the fate of Hogstrom, who afterward went abroad.—*London Engineering.*

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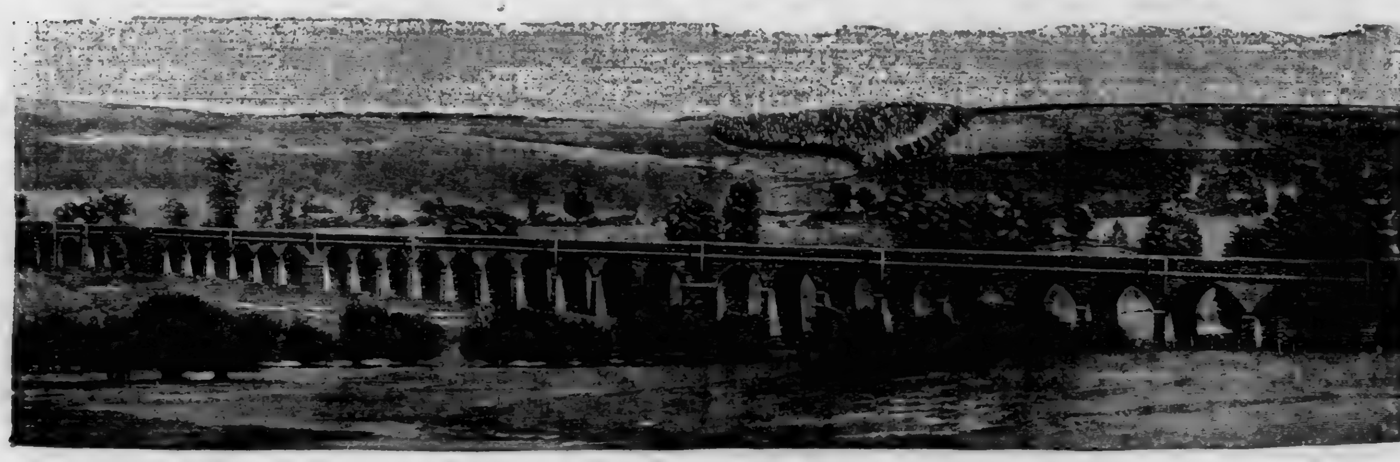

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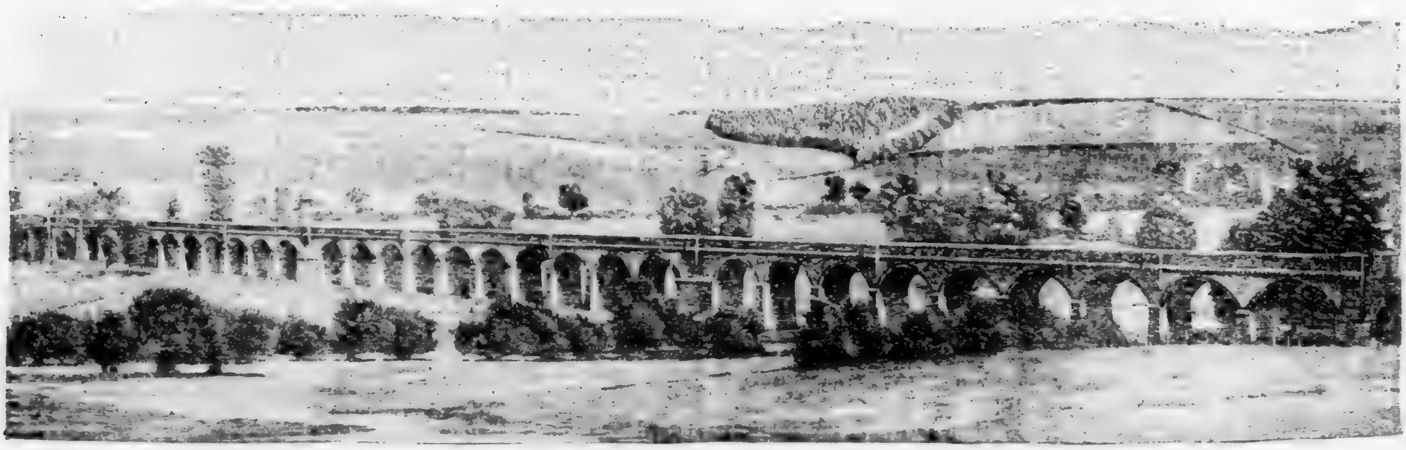

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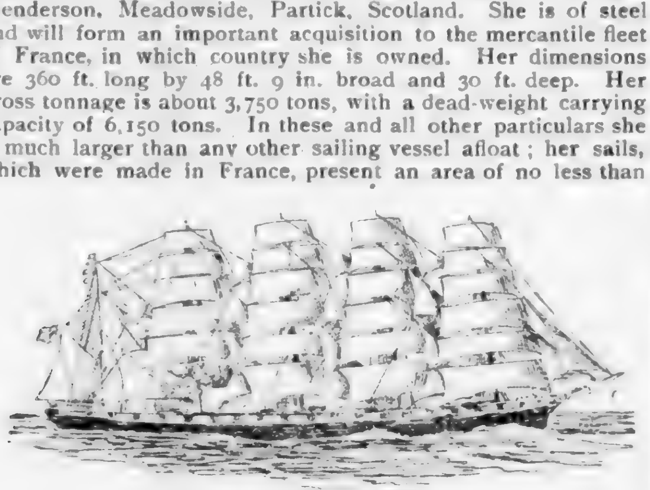

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company, and the agreement in its case was a surprise. The combination makes the Reading one of the great lines of the country, controlling a mileage much less than that of some of the Western companies in length, but of an earning capacity not surpassed in this country. Few lines, moreover, are in better physical condition and better equipped than the Lehigh Valley; the Reading and the New Jersey Central are behind it in this respect, though both roads are in much better condition than they were a few years ago.

As to the conditions, it may be briefly stated that the stockholders of the leased roads are guaranteed 7 per cent., with a share in all that may be earned above that amount.

A very important point about the agreement is that the combined companies control about 75 per cent. of all the anthracite coal mined in the country. Outside of it there will be left only four anthracite coal companies—the Delaware, Lackawanna & Western, the Delaware & Hudson, the Pennsylvania Coal Company and the companies controlled by the Pennsylvania Railroad—and there are rumors that the Lackawanna is to be brought into the combination. The conditions of the anthracite trade will be materially changed, and the Reading Company will be in a position which will practically enable it to control prices on the seaboard, where anthracite is chiefly used.

The other results of the new consolidation will be many, but the considerations affecting the coal trade are the most important at the present time. This is another instance of the tendency to consolidation of capital, which is such a marked feature of the present time.

CAR COUPLER AND BRAKE LEGISLATION.

FROM a half to a full dozen of different bills have thus far been introduced into Congress whose object is to make the use of automatic couplers and train brakes compulsory on the different railroads of the country. A glance over the provisions of these bills will show how crude most of these attempts at legislation are, and how futile and unwise the adoption of some of their provisions would be. The object aimed at in most cases is very commendable. The trouble is that if the provisions of the bills were enacted into laws they would not accomplish the purpose for which they are intended.

Some of the provisions are vague and indefinite, and if they became law it would often be difficult to know whether they were fully complied with or not. In one of them it is made unlawful to use a locomotive which "is not equipped with a *proper* power brake." Another provision is intended to prevent the use of cars which are not equipped with "*suitable* safety couplers." The question as to what are "suitable" safety couplers and "proper" brakes is left open. In another section "proper" safety couplers are designated, and one of the bills stipulates that the couplers used must be "simple" in their construction. Obviously such provisions would leave the question always open whether a brake was "proper," whether couplers were "suitable" or "simple," and would lead to endless disputes. The object of all the bills is to compel railroad companies to adopt some kind of automatic couplers and brakes on freight trains.

The question then arises whether compulsory legislation of this kind is wise. Evidently the framers of the bills thought so or they would not have had them proposed.

If the question was an entirely new one in legislation, the crudities contained in some of the proposed laws would be excusable, but it is not a new subject for law making. It has been before the different States in this country for years past, and the British Parliament has had the matter of legislation with reference to railway accidents under consideration for many years. As early as 1858 a Select Committee was appointed by Act of Parliament to inquire into the Causes of Accidents on Railways, and into the possibility of removing any such causes by further legislation. That Committee made a report on June 25, 1858, which was printed in the usual blue-book form in which parliamentary reports are issued, with 194 pages of printed testimony.* In this Report the Committee said:

"That it appears to your Committee that the strict personal supervision which alone can check the carelessness of the men employed on the lines, and detect the insufficiency of the material used on them, can best be obtained by the attention of the companies themselves, and that the very serious losses they incur by any accident ought to render it sufficiently their interest to pay minute attention to those points; but as cases have occurred where these questions have been neglected by railway companies, your Committee is of opinion that *the Board of Trade should be invested with the fullest powers to investigate, and report to Parliament, upon any accidents which may occur on railways.*"

The printed testimony which is published with the Report referred to contains a great deal of information and the opinions of many competent witnesses with reference to the advisability of compulsory legislation to prevent railway accidents. One of those who were examined was Captain Douglas Galton, who had then been connected with the Board of Trade as Secretary and Inspector for about eleven years. To a question, with reference to investing Government with powers effecting management, propounded to him, he said:

"I would rather leave all questions of management entirely to the companies, merely reserving to any Government department a power of full *inquiry* into accidents, and *publicity* in such inquiries."

Question. How far would you go, then, in Government control of railway companies?

Answer. Merely to the extent of *holding a public inquiry* into an accident, and *publishing the report as soon as possible* of such inquiry.

Q. Your recommendation would be to let the accident occur, and then to say why it did occur?

A. Yes. I think that any power of inquiry is desirable.

Q. Without the power of remedy?

A. Without the power of ordering specific remedies.

The following was the testimony of the Hon. Robert Lowe, a member of the Committee:

Q. Then at present the Board of Trade do not even possess the power of inquiring into accidents, and have no power to enforce any precautions against the recurrence of these accidents?

A. None whatever.

Q. Do you think that an advisable state of things, from your experience?

A. I think the latter part desirable, but the former un-

* For the benefit of those of our readers who are not acquainted with the fact, we will say that all parliamentary reports, which are not out of print, can be bought at a small price by ordering through an English bookseller. Messrs. P. S. King & Son, parliamentary and general booksellers, 5 King Street, Westminster, S. W. London, England, have served us in such business very satisfactorily.

desirable. In my opinion, they should not have the power of enforcing precautions; but I think it advisable that their officers should have the power of inquiry, of summoning witnesses, and of examining them on oath.

Q. Then you would give the Board of Trade the power of inquiry without the power of enforcing precautions?

A. I would say inquiry and *immediate publication.* I think that as soon as the Board of Trade have received a report from a competent officer, it should be published in the newspapers for the information of the public; but I do not think it advisable that the Board of Trade should interfere by special regulations for the enforcement of precautions.

The same witness testified that the shipping interest claims exoneration from responsibility, in consequence of the interference of the Board of Trade in the inspection of the steamers. The owners say, You inspect our steamers and satisfy yourselves that they are proper to go to sea; how unjust, then, to make us suffer in case any accident happens when you were satisfied yourselves! and they use it as a lever to get rid of the responsibility under which they are at present to pay, in case of injury occurring to their passengers; that, he said, was an evil, because he believed that the responsibility is the only check upon them which we have.

He said, further, if we began to interfere with the management of railways, it will be put to us directly that we must be prepared either to take the whole matter ourselves or to leave it to the companies. One interference necessarily leads to another; you cannot do one thing without altering a great many other things. You must provide for and consider everything if you once begin to interfere; and I do not see where you can stop. We should really have this dilemma before us, either to withdraw from all interference or to take altogether other people's property out of their hands, which, I believe, the Government would be extremely incompetent to manage.

He deprecated entirely any interference on the part of the Board of Trade with the management of railways, but did not deprecate an inspection by officers sent down by the Board of Trade.

This testimony is quoted—and much more to the same tenor might be given—because it evidently has given the key-note to the Report. The persons who have been quoted have had long experience in the Board of Trade, and naturally would desire rather to have its authority increased than diminished. After hearing all that could be said, the Committee recommended that the Board of Trade should be invested only with the fullest powers to investigate, and report to Parliament, upon accidents which may occur on railways.

An Act of 1871 made large provision for the inspection of railways by the officers of that department, and for the investigation by them of accidents in serious cases, the companies being bound to make report of all such casualties. A proposal in 1873 to enforce the adoption of the block system and make the interlocking system compulsory was abandoned on the recommendation of a select committee.

Another Commission, appointed to inquire into the causes of railway accidents, reported, in 1877, that the powers possessed by the Board of Trade and the Railway Commission are so adjusted and so limited as to leave with the companies the undivided responsibility of working their lines. The first and the most important question, therefore, the commissioners say in their report, which they have to consider as effecting the entire character of their report, is whether our investigations lead us to advise a departure from this policy, which has heretofore characterized railway legislation. With this point in view, a wide scope was given to their inquiry. Appended to their report are nearly 1,200 pages of printed testimony. Pages of this, given by persons of the widest experience in the management and supervision of railways, might be quoted against the wisdom of compulsory legislation; and the Committee in their report say that "upon full consideration we are not prepared to recommend any legislation authorizing such an interference with railways as would impair in any way the responsibility of the companies for injury or loss of life caused by accident on their lines."

From what has been quoted, it will be seen that the general trend of the investigations with reference to legislation on the subject of railway accidents has been against Government interference with the management of railways which would lead to divided control and diminished responsibility on the part of their managers. While this is the case, and while there is an obvious disinclination on the part of the commissioners to interfere, their conclusions, after the full investigation which was made, were stated by one of the commissioners, who made a minority report, and who said that "whatever defects there may be in the actual maintenance or working of our railways, it would be much better to leave them as they are than adopt any system of interference necessarily leading to a division of responsibility in their management. But the conclusion that '*any*' interference, either with the maintenance of works or management of traffic, must *necessarily* lead to a division of the companies' responsibility and control, is not the conclusion of the Commission."

In their report they say, further:

"The evidence before us shows that, notwithstanding a knowledge of this responsibility, exceptional cases have occurred in which companies have failed to secure a proper maintenance and repair of lines, the provision of such accommodation at stations as the traffic requires, and the prompt and efficacious adoption of such appliances and precautions as are best calculated to secure the public safety.

"We have carefully considered in what way pressure can be brought to bear upon railway companies which make default in these respects without impairing their responsibility for the safe conduct of their traffic, and we believe this may be effected by legislation enforcing upon them the adoption of certain recognized improvements, and the construction of necessary works, while leaving to the Railway Boards themselves the settlement of all matters of detail and of administration."

Further on in their report the Commissioners say: "In our opinion, the time has come when compulsion ought to be resorted to in exceptional cases where remissness is apparent in this matter. We do not think it desirable, however, that this should be done directly by statute, and, therefore, we recommend that powers be given to the Board of Trade to require the adoption of the block system, and of arrangements for the interlocking of points and signals, or of either of these, upon any line or any part of a line *when the department considers such a change necessary for safety.*"

Again the Commission says: "We find that in former

inquiries of this kind great stress has been laid upon the responsibility which the law imposes on railway companies to provide for the safety of their traffic, and we are unanimous and decided in our opinion that no legislation is desirable which would impair that responsibility. . . . In some instances, moreover, the general recommendations of the report would have assumed the form of distinct proposals for legislation, but that we feared lest we should thereby endanger this principle of the undivided responsibility of companies, which we regard as of fundamental importance."

From these quotations it will be seen how reluctant the successive commissions which considered and reported on this subject were to recommend compulsory legislation in the adoption of safety appliances. While the last one which reported did not go to the extent of saying that compulsion should never be resorted to, nevertheless, all that was advised was that the Board of Trade be empowered to enforce the adoption of certain safety appliances where that department considered such a change necessary for the public safety. Now it must be kept in mind that the British Board of Trade has a department specially organized for the supervision and inspection of railways, and has trained inspectors, who have been employed in such work for many years, and therefore have abundant experience and knowledge of the requirements of railway traffic and operation. Even with such a body as this all that the successive commissions appointed to consider the subject of legislation with reference to the prevention of railway accidents would recommend was to empower that Board to enforce the adoption of certain appliances "*whenever the department considers such a change necessary for the public safety*." If this action is compared with the conditions of legislation proposed in our Congress, it shows that the framers of at least some of the bills proposed are still apprentices in the trade of legislation.

No words could be written which will exaggerate the importance of preventative measures to lessen the terrible sacrifice of life and limb of railroad employés which goes on daily and hourly in this country. The question of the greatest importance is what legislation will be the most effectual in lessening this suffering. The purpose of this article is to show that the result of the fullest and most careful study of this subject by some of the ablest legislators in the world has led them to the conclusion that the most reliable means of reducing the danger of railroad accidents is thorough investigation of their causes by competent persons and published reports thereon. A great mass of testimony, given before the different commissions which have investigated this subject in England, might be quoted in support of this position. It should be kept in mind that no investigations of the causes of railroad accidents have ever been made in this country with the same degree of thoroughness; and no testimony has ever been taken here in which the opinions and experience of so many able and competent witnesses is given as is contained in the printed reports which have been referred to. It would, therefore, be the part of wisdom for our Congressmen to accept the conclusions of British legislators, at least until they have devoted a sufficient amount of study and have collected enough evidence on the subject to qualify them to draw conclusions based on an equal or greater amount of knowledge of the subject under consideration.

After a careful study of the subject we can say unhesitatingly that we are convinced that the most effectual means of lessening the danger and the number of accidents to railroad employés would be the creation of a Board, Commission, or authority of some kind, whose duty it would be to collect data concerning the number, nature and causes of accidents to railroad employés, with authority to require railroad companies to give the needed particulars concerning such accidents, and then to make public reports thereon at least quarterly. If such data was tabulated and analyzed, the chief causes of accidents would soon group themselves into classes, and the needed preventive measures would then become apparent, and public opinion would do the rest. If, for example, successive reports showed that an unusual proportion of accidents were caused by some particular kind of car-coupler or form of dead-blocks, no company would have the temerity to keep them in use in the face of successive reports of this kind.

The kind of information which our proposed Safety Commission should have the authority to exact would be the name of the person injured, the extent of injuries, the circumstances attending them—such as (in case of coupling accidents) the kind of couplers in use on the cars between which persons were injured—did the accident occur in coupling or uncoupling? were the couplers in good order? nature of their defects, if any; the height of draw-bars; amount of clear space between cars when dead-blocks or couplers come together; were hand-holds provided for the men to hold by in coupling or uncoupling; kind, size and form of dead-blocks on the cars; did the accident occur on a straight line or on a curve? in daytime or night? and amount of experience of the person injured.

These are mere suggestions, of course; doubtless a careful study of the subject would suggest other inquiries, and perhaps the omission of some of the above. A competent Commission could prepare a blank form to be filled out by railroad companies whenever any employé was injured so as to disable him. If such reports were collected of all accidents to employés in the whole country, and then carefully and intelligently classified and analyzed, it would throw a flood of light on the subject, and would at once indicate what preventative measures would be effectual in diminishing the present horrible fatality and suffering.

Whether such a Commission as is suggested should be a part or subject to the Inter-State Commerce Commission, or be independent of it, is a question for our legislators. The British Board of Trade has inspectors who investigate important accidents and their causes. If for the present Congress would do no more than appoint an Inspector-in-Chief of Railroad Accidents and Safety Appliances, with a few clerks, and authority to investigate and collect data and information from railroad companies concerning all accidents, and report thereon at least quarterly, it would probably do more for the safety of employés than any other legislation would at the present time. Frequent reports are essential, because their influence on the public mind and on railroad managers is in proportion to their frequency. If compulsion in the adoption of safety appliances was needed, the reports of such an authority would indicate just where and how legislative pressure should be exerted. In any event, all who have studied the subject are convinced that compulsory legislation should be adopted only as a last resort, and not, as in the case of most of the bills proposed in Congress, as a preliminary measure.

THE MONTHLY MEETINGS OF THE SOCIETY OF MECHANICAL ENGINEERS.

DURING last winter and the early part of this a series of monthly social meetings have been held in the house of the Society of Mechanical Engineers, on Thirty-first Street. These meetings were almost entirely of a social character, and if any technical subjects were brought forward they were popularized so that even the ladies who accompanied the members could comprehend them. While these meetings were enjoyed by those who attended them, there were, nevertheless, some expressions of opinion that they did not entirely fulfil what might be expected of the meetings of a Society of Mechanical Engineers. If this Society, it was said by some of the members, cannot bring forth anything more profitable than church sociables, then it is not fulfilling its purpose. While no objection was made to the social meetings, a demand was made for the consideration of technical subjects on certain occasions. In response to this sentiment the managers of the Society issued a call for an informal meeting, which was held in the rooms.

About thirty members met there on that evening, and it was announced that the subject for discussion was "Boilers." Too much formality in meetings is undoubtedly an evil, but on the other hand it is possible to err in the other direction. On the occasion referred to particular stress was laid on the "informal" features of the meeting, not even a chairman was appointed, and the privilege of smoking was urged to such an extent that all the smokers present seemed to consider it a duty to engage in that exercise. Perhaps the obligation seemed more imperative from the fact that free cigars were handed round. It is generally assumed by smokers that the preferences of non-fumigants are not deserving of respect if they interfere with the enjoyment of the devotees of the noxious weed. The right of protest, however, still remains. If smoking is essential to the success of these meetings, it is suggested that a mechanical device similar to that which is used in locomotive engine houses, and is lowered down over the chimneys to conduct the smoke out of the building, be arranged over each seat in the meeting room of the Society. This would prevent the smoking members from being nuisances to those who do not smoke, as some of them were at the meeting referred to.

As already mentioned, no chairman was appointed; the only formality observed was that the Secretary announced that it was a sort of go-as-you-please meeting, and all who chose to do so talked as they liked. It was an obvious mistake, however, not to have a chairman, and it was evident before the meeting was over that a head of some kind was needed to steer the discussion and limit its scope when it became too discursive.

Notwithstanding these drawbacks the meeting was an agreeable and profitable one. Much interesting talk was elicited and many instructive facts were presented, and it was evident that such occasions could be made very attractive to the members of the Society.

The reading of papers is apt to bore members, but too much informality—and smoke—diverts their attention. What seems to be needed is a meeting in which informal talk may be heard under just enough restraint to prevent too much scattering and to restrain the wind-bags within tolerable limits.

It is hoped that these meetings will be well attended and if properly directed, their success may be safely predicted.

THE NEW YORK RAILROAD CLUB.

THIS Association has gone through a great many transitions and vicissitudes. Its career in the old rooms on Liberty Street was well known to some of our readers, but since that habitat was abandoned its doings have been less known. After leaving them some of those who directed its affairs took rooms on Thirtieth Street, connected with the Gilsey House. These were kept open at all times with the expectation that members and others would make them a rendezvous for the transaction of business and for social intercourse. The experiment was tried, but the expectation was not realized. The rooms were seldom visited, and the only occupant was usually the attendant who was paid to be there. These quarters were therefore abandoned, and arrangements were made to hold the meetings in the house of the Society of Mechanical Engineers, at 12 West Thirty-first Street. Here there is an admirable assembly room, just about large enough for their meetings, and all the surroundings are propitious for scientific discussion.

At the last meeting some of the Rules of Car Interchange were discussed, and discussion was then opened for "topics." A member propounded the inquiry whether any material practical advantage would be gained if a locomotive could be perfectly balanced? That is, would an engine under these conditions run faster, burn less coal, wear longer, or in any way produce better practical results than our present locomotives do?

The discussion elicited the usual amount of vague opinion that is generally expressed when this subject is discussed. From what was said, however, it appeared that locomotives which are well balanced work much better—that is, run more steadily, than engines do which are not well balanced. Inasmuch as the balancing of locomotives is a matter of compromise—that is, whatever is gained by neutralizing the horizontal disturbance increases it vertically, and therefore all locomotives are very much out of balance, it was inferred that if a locomotive was perfectly balanced a very material advantage would be gained.

The subject was discussed at considerable length.

The inevitable hammer-blow was referred to, and authentic cases of the bending of rails by the counterweights of locomotives were inquired for. Some rather vague instances of this kind were referred to, but nothing very definite was presented.

It was pointed out that the vertical disturbance due to the unbalanced part of the counterweight was equal to its centrifugal force, which could easily be calculated, but that the effect of this on the rails was to a considerable extent neutralized by the inertia of the wheels, axles and connecting-rods, which resists the centrifugal force of the counterweights. This force is exerted first on the wheel, axle, etc., and is not transmitted to the rail until after the inertia of these parts has been overcome. This, of course, diminishes the effect produced on the rail very materially. A downward blow of a heavy sledge hammer on the top of a driving-wheel would produce very little effect on the rail, but if it was struck directly on the rail might be sufficient to break it.

The modifying influence of the inertia of the wheel, axle, etc., on the effect of the centrifugal force of counterweights on the rails, the speaker said, had never before been pointed out.

The discussion seemed to interest the persons who were present, and the meeting was continued until 10 o'clock. The Club may be congratulated on its improved environment. Heretofore there has always been some more or less sinister influences about the outskirts of the meetings. These have been entirely eliminated by the transfer to the Rooms of the Society of Mechanical Engineers.

NEW PUBLICATIONS.

TRIPLE-EXPANSION ENGINES AND ENGINE TRIALS. By Professor Osborne Reynolds; edited by F. E. Idell, M.E. The D. Van Nostrand Company, New York; price 50 cents.

This little volume, which forms No. 99 of the Science Series, gives a paper in which Professor Reynolds presented to the Institution of Civil Engineers the results of a series of trials made by him with an engine built for the Whitworth Engineering

Laboratory; it also includes a summary of the discussion on the paper, in which several well-known mechanical engineers took part.

The engine was built especially for experimental purposes, and was so arranged that by disconnecting the several cylinders it could be run as a triple-expansion engine; as a compound non-condensing engine; as a compound condensing engine; as a simple condensing engine, and as a simple non-condensing engine. Professor Reynolds' experiments were made with the triple-expansion engine at a boiler pressure of 200 lbs., and the trials were 32 in number, careful record being kept of each and numerous diagrams taken. The object was to secure the fullest possible record of the results, with notes as to priming, condensation and leakage, and also as to efficiency of the steam jacket.

The results are very fully given and were not in all respects such as were expected. Perhaps the most interesting part is the discussion.

MACHINERY PATTERN MAKING. *Containing Full-Size Profiles of Gear Teeth and Fine Engravings in Full-Page Plates, Illustrating Manner of Constructing Numerous and Important Patterns and Core-Boxes.* By P. S. Dingey, Practical Pattern Maker and Mechanical Draftsman. (New York. John Wiley & Sons.)

This book is a republication of a series of articles which originally appeared in the *American Machinist.* They were written by a practical pattern maker, and have the merits and faults which are characteristic of the productions of persons who have more experience in doing work than they have had in writing.

The chief fault of the literary work of authors with this kind of training and experience is that they do not say enough about these things which they know thoroughly well, and which are most worth writing about, but they give the greatest amount of attention to difficulties and doubtful points which they have encountered.

The different chapters contain a series of practical hints and suggestions concerning the difficulties of making various kinds of patterns for casting parts of machinery. In none of the chapters, however, are there any complete instructions given for making a pattern, but the little difficulties which a workman would encounter are pointed out, and many valuable suggestions are given for overcoming them. The author says that "the object of his book is not to teach pattern making, for that can never be done through a book, but to discuss methods." The latter is, of course, very true, but at the same time the usefulness of what he has written would have been much increased if he had given fuller directions with reference to the methods of making patterns, beginning from the first processes and showing in detail how the work progresses and is completed.

In the first sentence he calls attention to the value of an ability to read drawings to a good pattern maker. He might with advantage to his young readers have dwelt more at length on the value of a knowledge of drawing to those who make pattern making their occupation. There is hardly a step in that kind of work in which some knowledge of drawing is not essential. In the words of Mr. James Nasmyth, the inventor of the steam hammer, "mechanical drawing is the alphabet of the engineer," and, he said further, "throughout my professional life I have found this art to be of the utmost practical value."

The book we are reviewing can be recommended to pattern makers. Although it is not a very complete treatise on their art, it contains a great deal of valuable instruction, and will smooth over many of the difficulties which they encounter. It contains about 100 pages, is well illustrated and printed, and is easy reading, the style being clear and the text almost devoid of mathematical perplexities.

THE MECHANICAL ENGINEERS' POCKET-BOOK OF TABLES, FORMULÆ, RULES AND DATA. *A Handy Book of Reference for Daily Use in Engineering Practice.* By D. Kinnear Clark. (New York: D. Van Nostrand Company, 1892.)

A review of a book of this kind is about as difficult as it is to summarize the contents of a dictionary. The condensation of a great mass of information is necessarily the object aimed at by the author, and all that can be done by a reviewer is to give some idea of the scope of the book, which in this case can be done as well, or better, by quoting from the preface than in any other way. In that the author says that the book has been especially prepared for Mechanical Engineers, "for the purpose of shortening the calculations and other intricate mental operations which are among the daily recurring needs of mechanical men. To meet such needs," the author continues to say, "there will be found in the following pages about 350 tables of results of calculations, relating to the principal branches of mechanical practice, which have either been compiled anew or drawn from various sources. There are in addition about 500 formulæ and rules, with data of general utility, classified for ready reference. By their aid many a weary search in larger and more ambitious books may be dispensed with, and the labor of calculation greatly abridged, or even entirely avoided.

"Besides the usual indispensable mathematical tables and rules for measurement of surfaces and solids, full tables of English weights and measures, with French metric equivalents, are given; tables of French metric weights and measures, with equivalent English values, are also given.

"Many useful tables are given of the weights and strength of bars, sheets, beams, joists, girders, tubes, pipes, bolts, and nuts, cylinders, nails, chains, and other manufactured pieces.

"For the strength of materials, a variety of experimental evidence is quoted, with many new formulæ and tables. Heat and its application have been fully considered in various aspects. The best proportion of steam engines, simple and compound, are discussed, together with pumping engines, water-power, and compressed air power."

All of this has been admirably done, and the material is compressed into a convenient little volume, which measures 4×9 in. and $\frac{13}{16}$ in. thick. It is printed on thin paper, and contains 656 pages.

A table of circumferences, diameters, squares, cubes, square-roots and cube-roots, which is used oftener than anything else in a book of this kind, is very appropriately and conveniently placed first in the book. It is arranged in seven columns, giving all the data named above in one table, which makes it more convenient for ordinary use than it would be if the circumferences were given in one table, areas in another, and squares, cubes, and their roots in still another.

The index to the book is very good, and fills 16 pages, so it is obviously impossible even to enumerate a small portion of the contents of the volume.

The tables and data concerning weights and measures occupy 66 pages, and are very full and complete. This is also true of the portion relating to the Specific Gravity, Weight and Volume of different substances, and of manufactured metals. The latter portion contains tables not only of bar iron, but of bar steel and of a great variety of shapes, tubes, pipes, wire, beams, joists, girders, bolts, nuts, nails, rivets, plates, etc.

The portion relating to the strength of materials and structures is also very complete. The rules for making calculations all through the book are given in algebraic form, which, of course, is available only to those who know algebra. It is all of the simplest kind, however. The tables of the strength of iron and steel columns, beams, joists, and girders are very full and conveniently arranged.

The section on Mechanical Principles explains very clearly such subjects as the mechanical powers, the moments of forces,

centers of gravity, gyration, oscillation, percussion, the fall of bodies, work, etc. The rules and tables relating to the fall of bodies and accelerated motion are presented in a very clear form. In some pocket-books these subjects are involved in more or less foggy explanations. Mill Gearing, Heat, Warming and Ventilation, Steam, Steam Engines, and Boilers, Railways, Steamships, Coal Gas, Air in Motion, Water Power, and Electrical Engineering all have separate sections devoted to them.

The book may be highly commended, and it is certain that all mechanical engineers will find it a most useful companion, and that the more it is used the more will it be valued.

THE DEVELOPMENT OF THE AMERICAN RAIL AND TRACK, AS ILLUSTRATED BY THE COLLECTION IN THE NATIONAL MUSEUM. By J. Elfreth Watkins, Curator of the Section of Transportation and Engineering. The Smithsonian Institution, Washington.

In this monograph, which is a part of the report of the National Museum, Mr. Watkins has illustrated in a very interesting way the gradual growth and development of our present style of track. Beginning with the cast-iron rails laid on the old colliery lines, before the locomotive came into use, he has illustrated, from exhibits in the Museum, the old strap rail, the double-head, the various forms of compound rail which have been proposed from time to time, and has brought out with especial care the development of the form now in general use from the original T-rail, designed by Robert L. Stevens in 1830, which has all the elements of the present type, the only changes made in it being in weight and in some of the details of the section ; these changes being mainly due to improvements in material and in methods of rolling.

Mr. Stevens' claim to the invention of this type of rail has never been questioned, in this country at least. We have reproduced here from the report figs. 39 and 40, the first of which shows the first Stevens rails ; the shaded section shows the rail as originally designed in 1830, and the unshaded section the rail

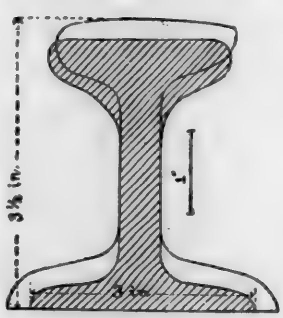


Fig. 39.

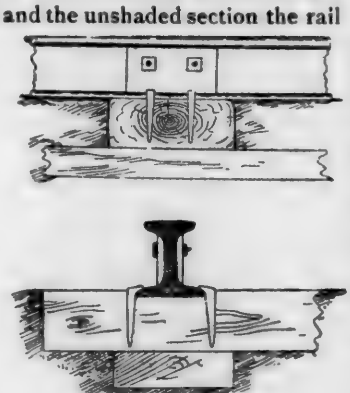


Fig. 40.

as actually rolled in 1831. Fig. 40 shows the standard track of the Camden & Amboy Railroad in 1837, with the bolted joint and spike fastenings. Both of these are from originals in the National Museum.

This monograph is an illustration of the uses to which the Railroad Department of the National Museum can be put. It is growing steadily, and under intelligent care, like that of the present Curator, it is likely to become a very valuable colection.

GEODESY. By J. Howard Gore, Professor of Mathematics in Columbian University. Houghton, Mifflin & Company, Boston and New York.

In this book of 220 pages, which is Volume IV of the Riverside Science Series, Professor Gore has given us a brief history of Geodesy. Of course it has been only possible to give a sketch within the limits allowed, the subject being an extensive one ; but the Author is a master of the subject, which he has made a special study, and his sketch is a very excellent one.

Beginning with some account of the primitive notions of the shape of the earth, the book describes the first real attempts to determine the size, when the real shape was understood ; the beginning of accurate determinations, the continuance of the work, and finally the systematic geodetic work as now carried on in various countries. England, France, Russia, Sweden, India and the United States each take a chapter under the last-named head. In this country some excellent geodetic work has been done, and the operations of the Coast Survey are worthy of much credit.

Professor Gore's book is a very interesting one, not only to the engineer, but also to the general reader, and is a thoroughly good piece of work.

ALMANACH DES KRIEGSFLOTTEN (NAVAL ALMANAC). Prepared by the Editors of the *Mittheilungen aus dem Gebiete des Seewesens.* Gerold & Company, Vienna, Austria.

The number of this *Almanac* for 1892 has, as usual, a large amount of information in a condensed form. It has a list of all the navies in the world corrected up to the latest possible date, and also tables of naval artillery, besides much other matter of use to the naval officer.

For the naval officer on duty, who is naturally obliged to condense his effects in a small space, this must be a very useful book, and it is no doubt thus appreciated.

RAILROAD MEN'S DIARY FOR 1892. The Taylor Iron & Steel Company, High Bridge, N. J.

This is the new edition of the very convenient pocket diary issued by the Taylor Company for a number of years past. In addition to the diary arranged for the year, there are a number of tables convenient for frequent use. It is handsomely bound and most convenient for all who carry a pocket diary and reference book.

UNITED STATES OFFICIAL POST OFFICE GUIDE, 1892. *Home and Country*, New York ; price, $2, paper, or $2.50, cloth.

This is a book hardly open to criticism. The nature of its contents and the fact that it is an indispensable aid to the business man are well known. The new edition contains the latest rulings and regulations of the Post Office Department, and the corrections seem to have been carefully and thoroughly made. The mass of information contained gives one some idea of the great and complicated work conducted by the Post Office.

TRADE CATALOGUES.

Notes on Power Plants for Electric Railroads, Electric Lighting, etc. Westinghouse, Church, Kerr & Company.

This pamphlet describes a number of power plants and shows the advantages to be gained by the use of high-speed engines and direct connected dynamos. It also gives some very remarkable instances of the excellent work done by the Westinghouse engine in such plants. This engine seems to be especially well adapted for electrical work, and its use for that class of work is extending.

Steam Engines and Steel Boilers Manufactured by The James Leffel & Company, Springfield, O.

This very neat and attractive-looking catalogue gives illustrated descriptions of the different patterns of engines and boilers made by the Company which issues it. These include stationary and portable engines of from 3 to 26 H.P., with suitable boilers ; the smaller sizes have upright boilers, which are often very convenient where economy of space is an object. The patterns of engines are compact and well-balanced, and the boilers are specially well designed for general service. The upright boiler with submerged tube-sheet is worth attention where

the upright type must be used. The smaller portable engines, which are shown in the catalogue attached to an upright boiler, would be an excellent type for wall engines in a small shop, or attached to a single line of shafting in a larger establishment.

Boilers and Boiler Attachments: San Francisco Boiler Works. P. F. Dundon, San Francisco, Cal.

One of the special types of boilers built by these works is described and illustrated on another page.

Corrugated Furnaces for Stationary and Portable Boilers: The Continental Iron Works, Brooklyn, N. Y.

This circular gives drawings of applications of the corrugated furnace to different kinds of boilers, with rules for the weight and thickness required for different pressures.

CURRENT READING.

THE Regents of the University of the State of New York have issued UNIVERSITY EXTENSION BULLETIN No. 1. This is to be the first of a series in aid of the movement, and is naturally devoted chiefly to a definition of its objects. The purpose of University Extension is stated to be "to provide the means of higher education for persons of all classes and of both sexes engaged in the regular occupations of life." The movement is a remarkable one, and has attracted much attention, and the Regents of the University propose to give it substantial assistance. The *Bulletin* will be sent to all who wish to aid in the movement.

The February number of GOOD ROADS contains a continuation of the article showing the difference between good and bad roads, illustrated in a very striking way by photographs taken of both kinds of highways. There is also a word from the farmers, and a description of the way in which a good system of roads was secured in Union County, N. J., besides a variety of practical and interesting matter. This magazine has been started to preach the Gospel of Good Roads, and it has begun its work well and with excellent promise for the future.

A new monthly magazine called MINERALS has been started by the Goldthwaites in New York, who are publishers of *Goldthwaite's Geographical Magazine*. As its name indicates, the new magazine is to be devoted to geology and mineralogy; it is handsomely printed, contains 32 pages of reading matter, and costs $1 a year. The January and February numbers, now before us, contain each a number of articles, generally short, and nearly all bright and interesting, and these numbers are in themselves an excellent promise for the future.

The February number of the ECLECTIC MAGAZINE has articles from nearly all the leading English magazines and reviews. The editor is usually very successful in choosing not only articles of current interest, but also those which illustrate the general drift of the periodicals. Among the more notable articles are Preventive Medicine, from the *Nineteenth Century;* Crime in Paris, from the *Fortnightly Review;* The New Astronomy, from the same periodical; The Riots in China, from *Blackwood's Magazine*, and The Decay of Originality, from the *National Review*.

In HARPER'S WEEKLY for January 31 there is a careful comparison of the navies of the United States and Chile. The number for February 6 has an illustrated account of San Francisco. The number for February 13 has an illustrated article on the Sims-Edison Torpedo, and views showing the progress made on the World's Fair buildings.

Our very lively and entertaining contemporary VARNISH, heretofore published by the Lawson Valentine Company, is now an independent journal under the management of Mr. Charles B. Sherron, who has been for some time connected with the paper.

No lover of travel or outdoor sports can fail to find some articles that will interest him in OUTING for February. Norway, the Pacific Islands, Manitoba, and the West furnish materials for descriptive articles. An article on Training gives some very useful hints to athletes, and the paper on Photography and Athletics gives some excellent reproductions of instantaneous photographs. The military article is on the Connecticut National Guard.

In the March number of the OVERLAND MONTHLY there are two articles of especial interest, the first being an account of a trip through the Cañon of the Colorado, made some two years ago by a party of engineers; the second is on Types of Indians, by Captain Dougherty, an officer who has made the subject a study. Both of these articles are well illustrated; there are also several other illustrated articles and an excellent variety of stories, sketches, and lighter matter.

In the ENGINEERING MAGAZINE for February Oberlin Smith answers the question, Who is an Engineer? G. W. Rafter writes on Gravity Systems of Water Supply; Albert Williams on American Mining; George P. Merrill on the Wind as a Factor in Geology; Gustav Halle on the Gold Fields of South Africa, and T. L. Greene on the Decline in Railroad Building. Dr. Coleman Seller's article on American Supremacy in Mechanics is continued, the present being the third installment.

Besides continuations of the papers on Series of Numbers and on Surveying Instruments, the COMPASS for February has articles on Saegmuller's Solar Attachment for Transits; Vanishing Point in Perspective Drawing, and on Speedy Calculators.

Among the articles in the POPULAR SCIENCE MONTHLY for March is one descriptive of the Cotton Industry of Brazil, by John C. Branner, and a very interesting one on the Social Statistics of Cities, by Carroll D. Wright. The paper for the month in the series on American Industries is on the Organ, by Mr. D. Spillane. There are several others worth mention and careful reading.

Among the books now in preparation by John Wiley & Sons, New York, is VALVE GEARS FOR THE STEAM ENGINE, by Professor C. H. Peabody. Another is THEORY AND PRACTICE IN THE DESIGNING OF MODERN FRAME STRUCTURES, written jointly by Professor J. B. Johnson, of Washington University, in St. Louis, C. W. Bryan, Designing Engineer of the Edge Moor Bridge Works, and F. E. Turneaure, Instructor in Washington University. To this list must be added a textbook on RETAINING WALLS AND MASONRY DAMS, by Professor Mansfield Merriman.

There are three articles in SCRIBNER'S MAGAZINE for March which ought to have special mention, although the whole number is a good one. The first is the concluding number of Mr. Coffin's paper on American Illustration; the second is the article on the Water Route from Chicago to the Ocean, by Lieutenant Charles C. Rogers; the third is the discussion of the question of Speed in Locomotives, by Theodore N. Ely, H. Walter Webb, and M. N. Forney.

The series of papers on London is concluded in the March number of HARPER'S MAGAZINE. Other interesting articles are the continuation of the history of the Northwestern Fur Trade; the Voyage Down the Danube, and a paper on St. Paul and Minneapolis. Some of the illustrations deserve especial notice.

In the March number of the ARENA there are, as usual, a number of articles deserving attention for strength and independence of thought, and the number is fully up to the high standard of this magazine.

BOOKS RECEIVED.

Papers of the American Institute of Mining Engineers. Published by the Institute, New York. This includes a number of papers read at the meeting held at Glen Summit, Pa., in October last.

The Case of William K. Tubman before the House Committee on Patents. W. K. Tubman, Baltimore.

Reports of the Consuls of the United States to the Department of State. No. 133, *October,* 1891. Government Printing Office, Washington.

Gas in Foreign Countries: Reports from the Consuls of the United States in Answer to a Circular from the Department of State. Government Printing Office, Washington. This is one of the excellent compilations from consular reports on special subjects, which the Bureau of Statistics of the State Department prepares and issues from time to time.

The Ventilation of Buildings. By Alfred R. Wolff, M.E. Second Edition; published by the Author, New York.

Catalogue of Books on Steam, Steam Engines, Machinery, Mechanics and Mechanical Engineering. The D. Van Nostrand Company, New York.

University of Pennsylvania. Courses in Mechanical and Electrical Engineering, 1891–92. Issued by the University, Philadelphia.

Transactions of the American Society of Mechanical Engineers: Vol. XII, 1891. Published by the Society, New York.

Selected Papers of the Institution of Civil Engineers. Published by the Institution, London, England. The present installment of these papers includes W. G. Walker, on a Four-screw Hopper Dredger; F. W. Wood and H. Hawgood, on Los Angeles Cable Railroads; E. R. Dymond, on Electric Lighting at Tamworth, N. S. W.; F. T. Joyce, on Queensland Water Supply; R. H. B. Downes, on Practical Astronomy; Abstracts of Papers in Foreign Transactions and Periodicals.

TECHNICAL SCHOOLS.

Courses in Mechanical and Electrical Engineering of the University of Pennsylvania, 1891–92.

The University of Pennsylvania has for some time given much attention to its technical departments, and the pamphlet before us shows very complete courses in mechanical and electrical engineering and in chemistry. The mechanical and physical laboratories are an important feature of the course, and are soon to be very much enlarged and improved.

The University has now in process of construction extensive buildings, which will add materially to the facilities of this department. Ground has been broken for a boiler house 100 × 50 ft., which, when completed, will contain examples of the best modern types of steam boilers. The plant will contain externally and internally fired shell boilers and several water tube and other boilers of the sectional type. These boilers will be erected in such a way that the students will be enabled to examine and test them and compare their workings for heating and power purposes under the same conditions.

Adjoining this building is to be the new engineering laboratory. This building is to be 100 × 45 ft. and three and one-half stories high. On the first floor are to be placed the engines and dynamos used for lighting all the University buildings. The engines will be of the best types, both simple and compound, and will be arranged so that all the information possible may be obtained by the students.

The dynamos to be used for lighting purposes will include examples of the best modern types of both direct and alternating current machines, and the students in this department will be given instruction in the commercial handling and testing of the plant. The plan at present followed of giving each student charge of all the machinery and apparatus in the department for a portion of his time, under proper supervision, will be followed in the new plant.

The remainder of the first floor will be used for the Department of Mechanical Engineering. The plant now in the college building will be removed to the new one. The Corliss and Porter-Allen engines now in the department will be used in the new building for testing purposes and for driving the laboratory and shop shafting. On this same floor the wood and iron working rooms will be located.

On the first floor the centrifugal pumps, water meters, Leffel and Pelton wheels will be set up, connected to the tanks on the fourth floor, and discharging into a passage fitted with a weir below the floor for the measurement of the quantity of water discharged. The pumps placed on this floor to return the water to the tanks will be fitted for testing purposes.

On the second floor will be located the mechanical testing laboratory. In this laboratory the testing machines now in the department will be placed and permanent places made for the apparatus used in testing materials, oils, cements, gauges, indicators, chimney gases, etc. The machinery on this floor will be driven entirely from the floor below. One portion of this room will be set apart for the handling of small dynamos and motors, the current being carried into the electrical laboratory for testing purposes. On this floor will be located also the offices, three class rooms, coat rooms and closets.

On the third floor there will be a large drawing room, one class room and the assistants' room. On this floor also will be the electrical laboratory, which will be of especial value. The currents from the dynamos in the lighting station, as well as from the dynamos in the mechanical laboratory, will be available for testing work. The laboratory is already equipped with apparatus for carrying on most of the tests required of the electrical engineer.

On the half floor above the third floor will be the model room and the blue-print room.

In the new building there will be altogether about 15,000 sq. ft. of floor space, all of which will be used for instruction in mechanical and electrical work only. The chemical and physical laboratories in the college buildings will also be used for instruction of students in those branches.

Harvard University: Summer Courses of Instruction, 1892.

A circular from Harvard University announces several courses of instruction for the next summer; among these are Physics, Geology, Engineering and Trigonometry. The courses in Field Engineering most interest us, and concerning them the circular says:

Two courses in Surveying will be given during the summer of 1892, each to begin on Wednesday, July 6, and to continue six weeks.

It is intended to give about eight hours per day to field or office work, including lectures, and to make the courses equivalent to the regular courses in the Scientific School designated as Engineering 2 and 4.

The Scientific School building will be open during the summer, and the School will have the use of its rooms, instruments and equipment.

The course in Topography will consist of practical instruction in topographical, land and city surveying. Actual surveys will be made, notes plotted, areas calculated, and maps completed in ink and colors. Practice will be given in leveling, in determination of grades, setting of grade stakes, contouring and the computation of earthworks. The instruction is intended to make the student familiar with the methods and instruments employed in surveying, and to enable him to perform the operations of plane surveying, leveling and plotting.

The course in Railroad Surveying will require a previous knowledge of, and familiarity with, surveying instruments, as well as of the elementary principles of plane surveying. It will include problems in simple and compound curves, turnouts,

economics of location, and earthworks. It is the custom to make reconnoissance, preliminary and location surveys of a railroad from three to five miles in length, including estimates, bills of materials, specifications and contracts for the construction of the same. The surveys are mapped, cross-sections plotted, and the work made in character as practical as possible.

It may be added that the cost of this summer course, including tuition fee, is estimated at from $61 to $90. The students will have the advantage of access to the Library and other facilities of the University.

SOME CURRENT NOTES.

THE finest and most complete dividing engine in the world has just been completed by Professor Rowland for the Johns Hopkins University, in Baltimore. Several years have been required to perfect this machine, which can rule 1,000,000 lines to the inch, and the greatest care has to be taken to secure its regular running. Its chief use is to rule the fine plates used for spectrum analysis; a plate or grating of this kind, about 5 in. in diameter, and ruled with 22,000 lines to the inch, takes about a week of constant work, night and day, to complete it.

PLANS have been prepared by an expert commission consisting of three engineers—Charles A. Allen, Augustus W. Locke and John W. Ellis—appointed a year ago, for abolishing the grade crossings of streets and railroad tracks in Worcester, Mass. There are now 39 such crossings in the city, a number of them being on busy and important streets. The plan presented by the Commission provides for raising the tracks in the Union Station 8 ft., so that the streets in the center of the city shall go under them. According to this plan, at Grafton Street the tracks will be elevated 7.90 ft. and the roadway depressed 10.10 ft.; at Green Street the tracks will be elevated 15 ft. and the street depressed 3 ft.; at Lincoln Square the tracks will be elevated 13 ft. and the street depressed 4 ft. The viaduct across Front Street connecting the Northern and Southern railroads is to be abolished, and a transfer freight yard established east of the Union Station. None of the present freight-houses or yards will be disturbed except that of the New York, Providence & Boston, which will have to be moved several hundred feet west. The expense of remodelling the Union Station is estimated at $150,000, and the total cost of the improvement at $2,094,000.

THE representatives of the Deep Water-ways Convention, recently held at Detroit, appeared in Washington recently at a joint meeting of the House Committee on Rivers and Harbors and the Senate Committee on Commerce, having in charge the preparation of the regular river and harbor appropriation bill. The delegation urged the importance of the construction of a 21-ft. channel from the head of Lake Superior through the various connecting links between the great lakes and through the Erie Canal to the sea. The cost of the improvements needed to complete the 21-ft. channel is estimated by competent authorities at $3,400,000; the probable yearly cost of maintaining the channel is not stated.

AT the hearing granted to representatives of the Detroit Deep Water-ways Convention by the River and Harbor Committee of the House and the Commerce Committee of the Senate, General Poe was again called upon for an opinion as to the possibility of a reduction of the level of the lakes by deepening their connecting channels. Although it is a cardinal principle in engineering that the system of dredging at one point in a body of water connecting others of different levels and depositing the material thus taken out at another place in the same body of water does not change the surface level in any case, this question has been raised many times, and will probably come up again at regular intervals in the future. A Toledo man—Samuel R. Backus—raised the question this time, and it has been given many columns of space in daily newspapers on the lakes. With a great deal of patience, however, General Poe has answered all questions regarding the subject, on the basis that one of the very first requirements when deepening the bars in a channel connecting pools having different levels, is that sufficient of the cross-section at the point of deepening must be obstructed to compensate for the increase due to the excavation. The excavation at the Lime-Kilns Crossing, he says, may be taken as an example. The stone removed from the excavation was deposited abreast of it, in a part of the channel that was not likely to be required. The contracts for improving Hay Lake Channel provide for the necessary dams to maintain the volume of discharge as at present. At St. Clair Flats Canal proper precautions were taken to maintain the volume of discharge. At the Lime-Kilns Crossing the course taken was hardly necessary, because the entire fall from the head of the improvement to Lake Erie does not exceed three inches; hence a rise of that extent in the level of Lake Erie would entirely drown out the whole improvement. But it was most convenient and economical to deposit the stone in accordance with the principle referred to.—*Cleveland Marine Review.*

ONE of the highest bridges in the world is now under construction over the cañon of the Pecos River on a cut-off line which the Southern Pacific Company is building from Helmet to Shumla, Tex. This viaduct is 2,180 ft. long and 328 ft. above the level of the river; it consists of 48 spans, alternately 65 ft. and 35 ft. long, supported on steel towers, with the exception of a few at the end, which rest on masonry piers. The 65-ft. spans are deck trusses, and the 35-ft. spans, over the towers, are plate girders. The central span, over the river, is a cantilever 185 ft. long. The highest tower is 321 ft. high; the towers are all 10 × 35 ft. at the top. The Phœnix Bridge Company is building the bridge.

THE Old Colony Railroad Company has asked the Massachusetts Legislature for permission to use electricity instead of steam as a motive power. It is said that experiments in this direction are to be made on some of the branch lines, for which legislative permission is necessary.

ON February 1, according to the tables of the *American Manufacturer*, there were in blast 305 furnaces with a weekly capacity of 192,647 tons of pig iron; a decrease of 5 furnaces in number, but an increase of 1,205 tons in weekly capacity, as compared with January 1. As compared with February 1, 1891, the statement shows the large increase of 31 in the number of furnaces, and of 53,308 tons in the weekly production.

THE rival projects for bridging the Hudson River at New York have had hearings before the Senate Committee at Washington, but without present result or apparent advantage to either.

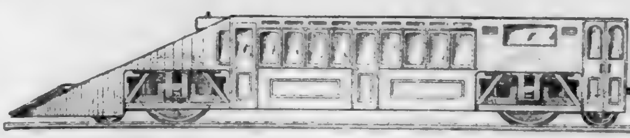
A NEW tunnel is now being built under the Thames River at Kingston, near London, by the Southwark & Vauxhall Water Company, under the direction of its Chief Engineer, Mr. J. W. Restler. This Company is building a line from Hampton to Nunhead, to furnish additional water to the reservoir at the latter place, from which several of the suburbs of London are supplied. With the exception of the section under the river, the new conduit consists of a cast-iron pipe 42 in. in diameter. In the section under the Thames this single conduit is replaced by two pipes each 30 in in diameter. These pipes are laid side by side in a tunnel of circular section 9 ft. in diameter. This tunnel is being constructed on the Greathead system, by means of a shield forced through the clay, which there composes the soil, and is lined with cast-iron sections bolted together in the same manner as the tunnel of the City & South London Railroad, and other works built on this system. The work is now well advanced, and the tunnel will soon be completed.

THERE are now in Germany only about 600 miles of canal against nearly eight times that length of rivers, which were originally navigable, or have been made so by works of improvement. This condition of things is rapidly being changed, however, as there are a number

of canals now under construction in that country, and surveys are being made for others. In the canal and river works of Germany no attempt has been made to secure a great depth of water, the engineers having generally contented themselves with a moderate depth, and with designing boats to carry the largest possible tonnage on a small craft.

OUR contemporary, the *Electrical World*, publishes with very little comment the prospectus of Dr. Wellington Adams, who proposes to build an electrical railroad between Chicago and St. Louis, and to run trains thereon at the rate of 100 miles an hour. The road is to be an air line and is to have four tracks, two for through traffic and two for local traffic and express freight. The power station is to be at the mouth of a coal mine on the line, so that fuel can be very cheaply obtained. How the power is to be transmitted—by overhead or conduit lines—is not stated, but the prospectus says that the entire line will be provided with electric signals and lighted at night with electric lights, and there will be no possibility of accident.

The cars will be of the pattern shown herewith, with two pairs of driving-wheels, each run by a separate motor. The wheels will be 6 ft. diameter, but the car will be low,



the body being hung between the driving-axles. The plow or wedge-shaped nose in front is to diminish as much as possible the resistance of the air at speeds of 100 to 120 miles an hour. Each car will be complete in itself, having a baggage compartment at one end, its own motors and heating and lighting apparatus.

ONE of the most remarkable steel castings recently made is the box-slide for the 12-in. turret mount for the battle-ship *Puritan*, which weighed, when shipped from the works of the Midvale Steel Company, 15,547 lbs. The Government specifications were: Tensile strength, 65,000 lbs. per square inch; elastic limit, 25,000 lbs.; extension, 15 per cent.; contraction, 25 per cent. The actual results of tests made from the casting itself showed: Tensile strength, 65,174 lbs.; elastic limit, 31,058 lbs.; extension, 25.10 per cent.; contraction, 35.04 per cent. The casting itself is of box form and not by any means an easy one to make.

NEARLY 5,000 ft. of the water-power tunnel at Niagara Falls has been excavated, and the work is progressing rapidly.

THE standard railroad gauge in the Argentine Republic is 5 ft. 6 in., but there are now over 2,600 miles of 4 ft. 8½ in., or narrow gauge, as it is called there. The longest line of this gauge is the Cordoba-Tucuman, which with the Jujuy extension, is 563 miles long. A line lately completed is the Cordoba-Rosario, 127 miles in length, with a branch of 38 miles. This line runs through a good country and connects Cordoba with the port of Rosario.

NEW railroad construction continues in Uruguay, though it has almost entirely stopped on the other side of the River Plate. The northern extension of the Central Uruguay line is now completed to Rivera, on the line between Uruguay and the province of Rio Grande do Sol, Brazil. Rivera is 352 miles from Montevideo, the starting-point of the road.

Not much attention is paid to fast running, however, since the time from Montevideo to Rivera is 21 hours, or about 16⅔ miles an hour. Time is of less importance there than here, however, and the traffic is not heavy enough to warrant the running of fast trains.

THE Dickerson Mine, in Morris County, N. J., has been shut down, and will probably never be reopened, as its working no longer pays. This has some historical interest, as the Dickerson is one of the oldest iron mines in America, having been first opened in 1716. It is said that iron from this mine was worked up into cannon balls during the Revolution, and the story is at least probable. Later it was one of a group of mines, the ore from which was worked up into bar iron and other shapes in the numerous small forges, each with its trip-hammer worked by water-power, the ruins of which can be found all over Northern New Jersey. Later still, the ore was sent over the Ferro-Monte Railroad to the Morris Canal, and thence by water to the furnaces. This ore was always of excellent quality and in good demand.

THE Argentine Government proposes to regulate railroad tariffs, and a recent decree directs the guaranteed railroads to submit their tariffs to the National Railroad Board, which will have authority to approve or to reject them and order changes. The Board is instructed to take into account not only the expenses and charges of the railroads, but also the interests of the people along the lines and the possibility of building up traffic.

The Government has a large direct interest in the question, for the Argentine railroad debt now amounts to $80,000,000 gold, and the yearly charge to $4,000,000. This is on account of the guaranteed lines only.

THE Japanese railroad system continues to grow steadily. In 1890 there were 222 miles of new railroad opened to traffic, and work was begun on new Government lines which will be 185 miles long when finished. Charters to build 127 miles were issued to private companies, and preliminary authorizations for 300 miles more were granted. Considering the conformation and size of the country, it may be said that in a few years Japan will be well supplied with railroads.

THE extent of the street railroad interest in the United States may be estimated from a recent report, which states that there are 5,783 miles of such roads in operation, having 32,505 cars and employing 70,764 men. The total number of passengers carried last year was 2,023,010,202; being 349,820 per mile of road worked and 62,237 per car. Philadelphia is the leading horse-car city, having 277 miles of street railroad; Boston (including Lynn and Cambridge) is second, with 238 miles; Chicago third, with 193 miles; New York fourth, with 181 miles. Four other cities have over 100 miles each: Brooklyn, 173; St. Louis, 115; New Orleans, 113; and Baltimore, 101 miles.

NO work is now in progress on the tunnel under the Hudson River at New York. The present stoppage is due to lack of money, as the work was advancing without difficulty when it was stopped.

A NEW type of ship approaching the "whaleback" has been patented in England by Doxford & Sons, ship-builders of London, who propose to build cargo steamers on this plan. The patent shows a "whaleback" with some modifications intended to adapt it better to ocean work.

A FRENCH FAST LOCOMOTIVE.

(Condensed from paper by M. Max de Nansouty in *le Genie Civil*.)

THE Eastern Railroad Company of France has just completed the first of 12 locomotives intended to run the fast express trains of the line from Calais by way of Laon to Basle. This is one of the main lines of Continental travel, making connections not only with the Swiss lines, but also for Italy by the Gothard Tunnel, and for Austria by the Arlberg, and the trains are often heavy, consisting of 18 and 20 carriages, including a sleeping car. The service has heretofore been performed by engines of the Crampton type, but when the trains were heavy it has been necessary to use two engines, and the company some time ago decided to build a special class of locomotives for the work.

These engines, of which No. 802 is the first, were designed by M. Salomon, Superintendent of Motive Power, and M. Flaman, Chief Mechanical Engineer of the Com-

pany. Their object has been to secure great steaming capacity, stability at high speeds, and a certain amount of flexibility in order to avoid too great shocks to the road-bed. Flexibility has been secured by adopting the American type of four drivers and a four-wheeled truck; stability by avoiding all overhanging weight and by placing the cylinders as near the center of the engine as possible.

The boiler adopted for these engines is of a new type designed by M. Flaman; this boiler was described and illustrated in the JOURNAL for January, 1892, page 25. To repeat briefly here, it has the barrel entirely filled with tubes, and above the main boiler it has a supplementary barrel or drum, of somewhat smaller diameter, connected with the main barrel at several points and joined at the rear to the outside fire-box casing. An experimental boiler of this type was put in one of the old Crampton engines some time ago, and has worked so well that it was decided without hesitation to use it for the new engines.

In No. 502 the fire-box has been made large in order to suit the fuel used, which is slack coal with a mixture of about 20 per cent. of briquettes or prepared fuel pressed into cakes. The fire-box is 40 in. wide inside and 75½ in. deep at the front end; the grate area is 26 sq. ft. There is an arch or deflector connected with the water spaces at each side. The crown-sheet of the fire box is arched and is of corrugated steel; there are no crown-bars.

The main barrel of the boiler is 47½ in. in diameter and contains 323 tubes 1.57 in. in diameter and 14 ft. 11½ in. long. The upper barrel or drum is 31½ in. in diameter and has three connections with the main barrel.

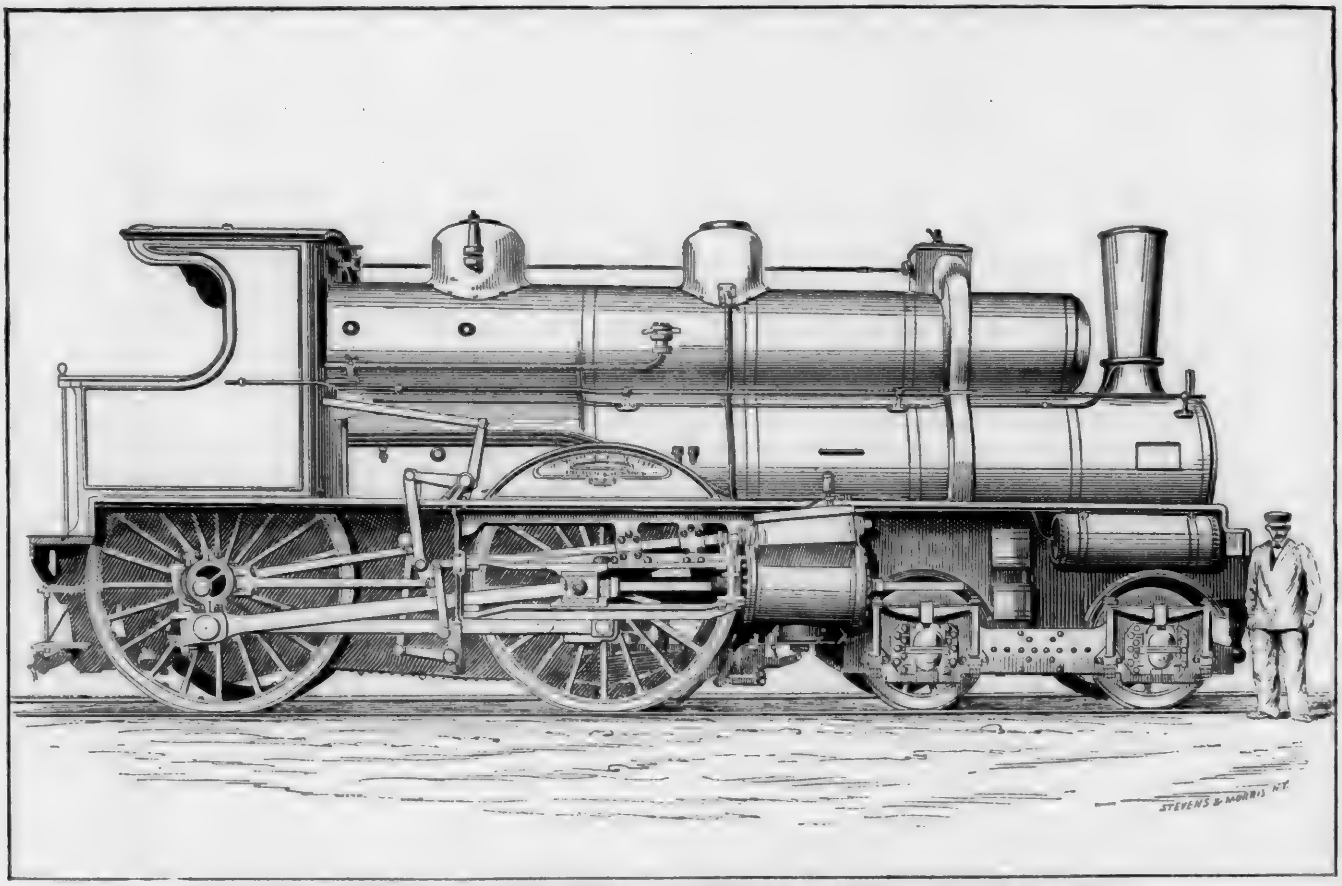
The total heating surface is: Direct (fire-box), 170.7 sq. ft.; indirect (tubes), 1,768.3 sq. ft.; total, 1,939 sq. ft. The normal water level is about the center line of the upper barrel.

These boilers were made with the greatest care. The steel plates were all carefully reheated and annealed after flanging. The tubes are of mild steel.

The running gear consists of four coupled wheels 82¼ in. in diameter and spaced 9 ft. 10 in. apart and of the four-wheeled truck. The truck wheels are 42½ in. diameter and are 6 ft. 2⅝ in. between centers. The total distance from center of rear driver to center of forward truck axle is 24 ft. 4¼ in. The distance from center of forward driver to center of truck is 11 ft. 5⅝ in. One pair of drivers is in front and the other behind the fire-box.

The truck frame is of steel plate. A lateral motion is allowed the center-bearing, and is controlled by an elliptic spring on each side. In this way the engineers have reached the object attained in this country by the use of the swing bolster. The truck is shown in detail in figs. 1, 2 and 3 herewith; the figures given in these are in meters.

The cylinders are placed as ear the center of the engine as possible, and are outside. They are 19.7 in. in diameter and 26 in. stroke. The cylinders are horizontal, but the steam-chests are inclined; a section of the cylinder, and a side view, showing the attachments to the frame, are given in fig. 4



FAST PASSENGER LOCOMOTIVE, EASTERN RAILROAD OF FRANCE.

The valves are slide-valves of the pattern ordinarily used on the road. The valve-motion is of the shifting-link type and is placed entirely outside, the eccentrics being carried by an arm attached to the crank-pin. In this case this was made necessary by the position of the main drivers back of the fire-box; but the placing the valve-gear outside is not uncommon in France.

The steam-pipes are carried down outside the boiler. The position of the cylinders, in fact, requires a somewhat awkward arrangement of both the steam and exhaust-pipes.

The main rods are 9 ft. 3⅝ in. long; they are connected to the rear pair of drivers. The guides are double and the cross-head is of the box type.

The engine is 34 ft 1¼ in. long over all. The weight, ready for service, is: On rear or main drivers, 35,830 lbs.; on forward drivers, 36,320 lbs.; on truck, 50,800 lbs.; total, 122,950 lbs.

The tender is carried on six wheels 48⅞ in. in diameter. It is 24 ft. long over all and has a wheel-base of 12 ft. 9¼ in. The springs of the two rear pairs of tender wheels are equalized.

The engine is fitted with the Westinghouse air-brake. The compressed-air reservoir is placed beside the smoke-box, immediately over the truck, and the air-pump is just behind it. There are no driver brakes on the engine; the tender has brakes fitted to all the wheels.

The tender frame is of steel plate. The engine frames

are also of the plate type, the main frames being of steel plate 1.18 in. in thickness.

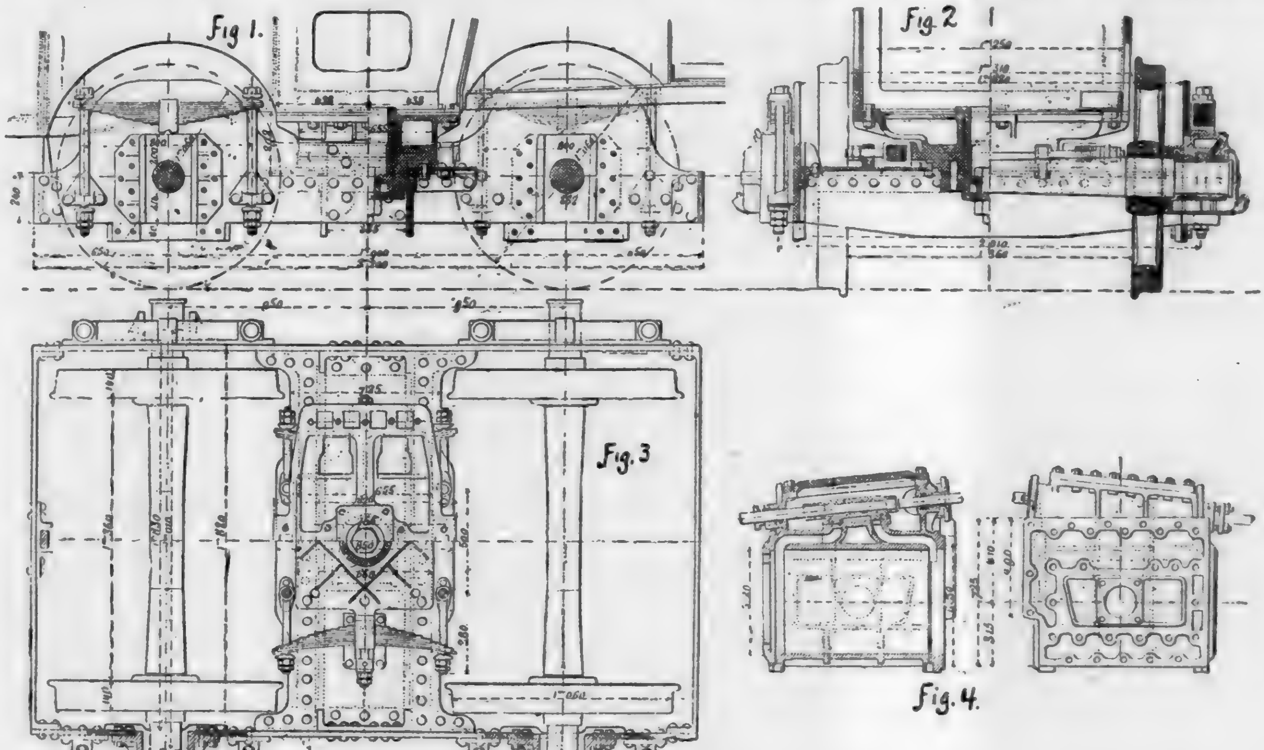
A number of experimental trips made with this engine gave the following results :

1. Trains of 660 tons total weight hauled up along grade of 0.8 per cent. at a uniform speed of 12¼ miles an hour.

2. Trains of 231 to 242 tons total weight hauled at an average speed of 47½ miles an hour over an undulating section of road, with grades varying from level to 0.3 per cent., and having two short grades of 0.6 per cent.

3. Trains of 154 tons total weight hauled over the section described above at an average speed of 56 miles an hour.

In these statements weight of engine and tender is included in that of train, and the weight is given in tons of 2,000 lbs.



FAST LOCOMOTIVE, EASTERN RAILROAD OF FRANCE.

In regular service these engines will have to draw trains of 220 to 240 tons total weight, and will have to maintain a speed of 40 to 45 miles an hour over stretches of considerable length. The line over which they will work is undulating in character, with frequent grades of 0.6 per cent., or 31.68 ft. to the mile, and some of 0.8 per cent. The road-bed is excellent ; the rails are of the Stevens type, and not heavy, being for the most part about 60 lbs. to the yard.

It should be said that in designing these engines, MM. Salomon and Flaman considered the compound type, and finally decided not to adopt it, their reason being that the complications required by the additional cylinders and valves were not desirable in locomotives intended for such service. In this conclusion they differed from M. du Bousquet, Superintendent of Motive Power of the Northern Railroad of France, who has adopted the four-cylinder compound type for the heavy fast engines on his road.

NEW ZEALAND RAILROADS.

An interesting paper on the railroads of New Zealand was recently read before the Australian Association for the Advancement of Science, by Railway Commissioner J. P. Maxwell. Nearly all the New Zealand lines have been built and are worked by the Colonial Government, and have been located rather with the intention of aiding in the development of the country than of realizing an immediate profit. Nevertheless they are now realizing about 3 per cent. interest on their cost.

The lines include in all 1,726 miles of 3 ft. 6 in. gauge, including a large proportion of branches in the mileage. In the South Island there is one system, the Hurunui-Bluff, with 1,069 miles of road ; in the North Island there are four systems : the Auckland, 254 miles ; the Napier, 97 miles ; the Wellington, 91 miles, and the Wanganui, 215 miles. There are many heavy grades, and on the Wellington Section there are 18 miles crossing a mountain range worked on the Fell rack-rail plan, and having grades as high as 352 ft. to the mile.

The total cost of the railroads has been $62,033,000, or about $35,940 per mile. In 1890 the net earnings were $1,863,000, or $1,080 per mile.

Much of the business is done in competition with sea transportation. There is little coal or other heavy freight. The kind of business done is shown by the reports for the year named, when the average passenger journey was 11.31 miles and the average freight haul 28.17 miles ; the average freight train load was only 17.35 tons. The statement shows for the whole mileage a yearly average of 1,548 train-miles, 32,796 passenger-miles, and 26,859 ton-miles per mile of road.

Some interesting particulars are given below from Mr. Maxwell's paper :

The character of the rolling stock is now tolerably uniform. The carriages in use are for the most part of the American type. The goods stock is mostly four-wheeled, that being best adapted to the light traffic, but a certain proportion is of American type. A capacity of 6 tons to a non-paying load of 3½ tons is general, and in the American types a capacity of 16 tons to a non-paying load of 7 tons. All the stock has oil-boxes.

The locomotives, for the most part, are small types of engines, fit for light traffic on steep grades with sharp curves. As a rule, they have under 20 tons on the coupled wheels. The heavier types are eight-wheel coupled tender-engines, with as high as 27 tons on the coupled wheels, suitable for minimum curves of 7½ chains radius. The use of bogies, compensating levers, balanced slide-valves, and sight-feed lubricators has been generally introduced. American or Russian oils are chiefly used for lubricants. The average mileage per engine is about 14,000 miles per annum, a very low result, due to short services and long-standing hours. The average cost per engine-mile for all locomotive expenses is 19.1 cts. This average includes the Fell engine services on the Rimutaka incline of 1 in 15, which has a center rail for about 2½ miles. The Fell engines weigh 36 tons, and draw a gross load, exclusive of their own

weight, of 70 tons up 1 in 15 at about five miles an hour. These engines ran 17,900 miles in one year, being 624 days in steam, and costing 92 cts. per engine-mile.

Methods of working are uniform throughout the colony. Unskilled wages cost $1.56 and skilled wages $2 to $2.63 per day of eight working hours.

The extreme speed of trains between stations is fixed at 36 miles per hour.

The Winter block-system is in use on certain parts of the lines where the traffic and other circumstances make it necessary.

The rails are, for the most part, of 40-lb. iron and 53-lb. steel. Some 30 lb. rails have been used on branch lines. All renewals are made in 53-lb. steel.

Structures and buildings are chiefly of wood. Combined wood and iron bridge-trusses are largely used. The bridging

is very extensive in some instances, as in the Rakaia, Rangitata, and Waitaki, the river-beds being nearly a mile in width.

There are no difficulties from frost or snow, but extensive floods have to be dealt with occasionally.

The cost of improvements in renewing iron rails with 53-lb. steel rails, in reconstructing improved types of rolling-stock, and more permanent structures is borne by the working-expenses. This makes the expenses appear heavier than they otherwise would do.

The average age of the lines is a little over 12 years. The full average cost of renewals will not, therefore, be reached under three or four years more. The cost of renewals of rails and sleepers and new works is about one-third of the whole cost of the maintenance of way and works.

The expenses of maintenance of the railways under consideration, of $610 per mile, must be considered very low under these circumstances.

The average number of hands employed is 2½ per mile in all departments. The stations are very numerous—more so than the traffic justifies; about one-half of them only are manned.

It would seem from the statements that the roads are worked carefully and as economically as possible. New Zealand is largely a pastoral and not a grain-raising country, and this, with the absence of large deposits of coal and other minerals, makes it probable that the population will never be dense, and that the railroads will never have a very heavy traffic. Probably the system of light roads adopted there will prove to be sufficient for the needs of the country for many years to come.

THE UNITED STATES NAVY.

THE possibility of war with Chile caused much activity in the Navy Department, and the work which was actually done showed how quickly the ships we have can be put on a war footing. As nearly all of them are simply cruisers, however, the occasion served to show that the battle-ships now in progress are needed, if we are to have war at all. These, with two or three torpedo cruisers, seem to be the vessels most required.

The Navy Department chartered the steamship *Ohio* with the view of fitting her out as a floating machine-shop—a very necessary adjunct to a fleet of modern war-ships. The building of a ship specially fitted for this purpose would seem to be desirable.

THE armored cruiser *Maine*, at the New York Navy Yard, is now ready for her armor-plates. The side armor, 10 in. in thickness, is to come from the Bethlehem Iron Works, and the 8-in. plates for the turrets are in course of manufacture at the works of Carnegie, Phipps & Company, near Pittsburgh.

The boilers of the *Maine* are now being put in place; and the engines, which are all ready, will be in the vessel before long.

THE cruiser *Cincinnati*, one of the two 3,000-ton ships, is now so well advanced at the New York Navy Yard that she will probably be launched in June next. Some delay in the work has been caused by slow delivery of the plates for the protective deck. The engines for this vessel and those for the *Raleigh*, which is being built at the Norfolk Yard, are now well advanced, and the boilers will soon be ready.

ORDERS have been given to fit out the *Vesuvius* for another test of her pneumatic dynamite guns. The trial is to take place at an early day under the supervision of a special board of naval experts in ordnance, and in addition to a readjustment of the gun-working valves of the middle and port guns and changes in them, the projectiles have to be made for the test. These are being made at the John Russell Machine Works, Springfield, Mass. There are 75 to be made, at a cost of about $150 each; each of them will be 8 ft. in length. There are two special reasons for making this test, one of which is to determine whether the vessel shall remain a dynamite cruiser or be transformed into a torpedo cruiser for more effective war service; and the other is that the Secretary of the Navy may determine whether her duplicate, for which Congress provided, shall be built.

THE ENGINEERING CONGRESS OF 1893.

THE Executive Committee of Engineering Societies has issued a circular in relation to the Engineering Congress proposed in connection with the Columbian Exposition next year. The substance of the circular is as follows, after referring to the organization of the "World's Congress Auxiliary:"

The General Committee has proposed a plan for the organization of the Congress and its classification in seven general divisions, which will work separately, but meet together on occasion. The following list of subdivisions indicates the classification. It is proposed to assign the work of organization and management of the various divisions as stated below:

Division A, Civil Engineering, to American Society of Civil Engineers; Division B, Mechanical Engineering, to

American Society of Mechanical Engineers; Division C, Mining Engineering, to American Institute of Mining Engineers; Division D, Metallurgical Engineering, to American Institute of Mining Engineers; Division E, Electrical Engineering, to American Institute of Electrical Engineers; Division F, Military Engineering, to Engineer Officers, U. S. A.; Division G, Marine and Naval Engineering, to Engineer Officers, U. S. N.

The order of proceedings, and the list of subjects from which selections may be made for the work of the Congress, are tentative, and suggestions are cordially invited.

There will probably be occasion for several joint sessions of two or more divisions, to discuss questions of general interest; and these, together with the programme and the order of papers and discussion—to avoid duplication or mutual interference—will be in immediate charge of the General Committee of the Auxiliary, in consultation with the officers of the several divisions.

It is desired that the various bodies to whose care these several divisions are entrusted shall take early steps toward organizing their division. Having already their own organizations and established relations, they are in the best position to begin the preparatory work at once, and to prosecute it to a successful termination with scarcely any expense.

The usual plan heretofore in vogue for organizing International Congresses in Europe has been to appoint in advance a number of Honorary Presidents, who act virtually as patrons, two Chairmen and four to six Vice-Chairmen, to provide for unexpected disabilities; four or five Honorary Secretaries and one General Secretary; also an Advisory Council comprising both home and foreign members; in addition to which foreign and domestic kindred societies have been invited to send delegates to the Congress.

The various engineering societies to whom the several divisions are assigned may either pursue this plan, or they may, if they prefer, organize the division through their own regular officers, making such additions thereto as suggest themselves, to give a representation to kindred organizations, etc. They may also prefer to have this Congress take the place of their regular summer meeting, including therein all local societies and delegates of engineering societies throughout the world.

All this may be done subject to approval by the General Committee of the Auxiliary, as seems best to each society; but the important part of the work to be done would appear to be to provide in advance for the selection of interesting subjects for discussion; the preparation of analyses of subjects, and the perfecting of arrangements which will insure desirable contributions to the discussion; also the securing of valuable voluntary papers, their examination, etc., and arranging for their discussion.

These papers should be invited from engineers all over the world, in order to make the Congress truly international, and should preferably treat of new and important constructions, machines, processes, methods, etc., provided they are in actual use, or experiments and investigations including proposed standard of tests and measurements. Advance copies or abstracts will be printed at the expense of the "Auxiliary" or of the Associated Engineering Societies, as may hereafter be determined, and the papers and discussions or translations thereof, if the original be in French, German, Spanish, etc., may be included in the transactions of the society organizing the division. It is, moreover, expected that they will also be printed in the publication contemplated by the "World's Congress Auxiliary," which is to furnish also the halls and rooms for holding the Congress.

Mr. E. L. Corthell is Chairman of the Executive Committee; Mr. Charles C. Bonney is President of the Auxiliary.

THE PENNSYLVANIA RAILROAD RELIEF FUND.

(From the *Pennsylvania Railroad Men's News.*)

ONE of the newest departments in railroad service in this country, and one in which a corporation most clearly shows its interest in the well being of its employés, is the Relief Department.

This department has the physical happiness of the railroad employés who are connected with it as its chief object, and pays to the deserving disabled and the beneficiaries of the deceased certain specified sums of money. The source from which all such payments issue is called the Relief Fund, and those entitled to its benefits are "members of the Relief Fund."

The largest relief fund in the world is the one connected with the Pennsylvania Railroad. It has more than 27,000 of the employés of that road interested personally in its conduct. This interest is caused by the fact that every contribution paid by them goes to aid their own or their fellow-member's family in times of distress. They are the sole owners of the fund.

In many respects the association of the members in this fund is similiar to mutual benefit societies, which are numerous throughout the country; and in this, as in other societies, each member sees that his disabled neighbor is properly reported and receives the benefits due him, and that no fraudulent cases of disablement are allowed to draw benefits from the fund; in this work he is doing what is entirely proper, in guarding alike his own and his neighbor's investments.

When members are disabled they are paid benefits from the fund they have helped swell. This obviates the humiliating necessity of old—that of passing a subscription paper about, soliciting contributions for some poor man who had been injured or sick.

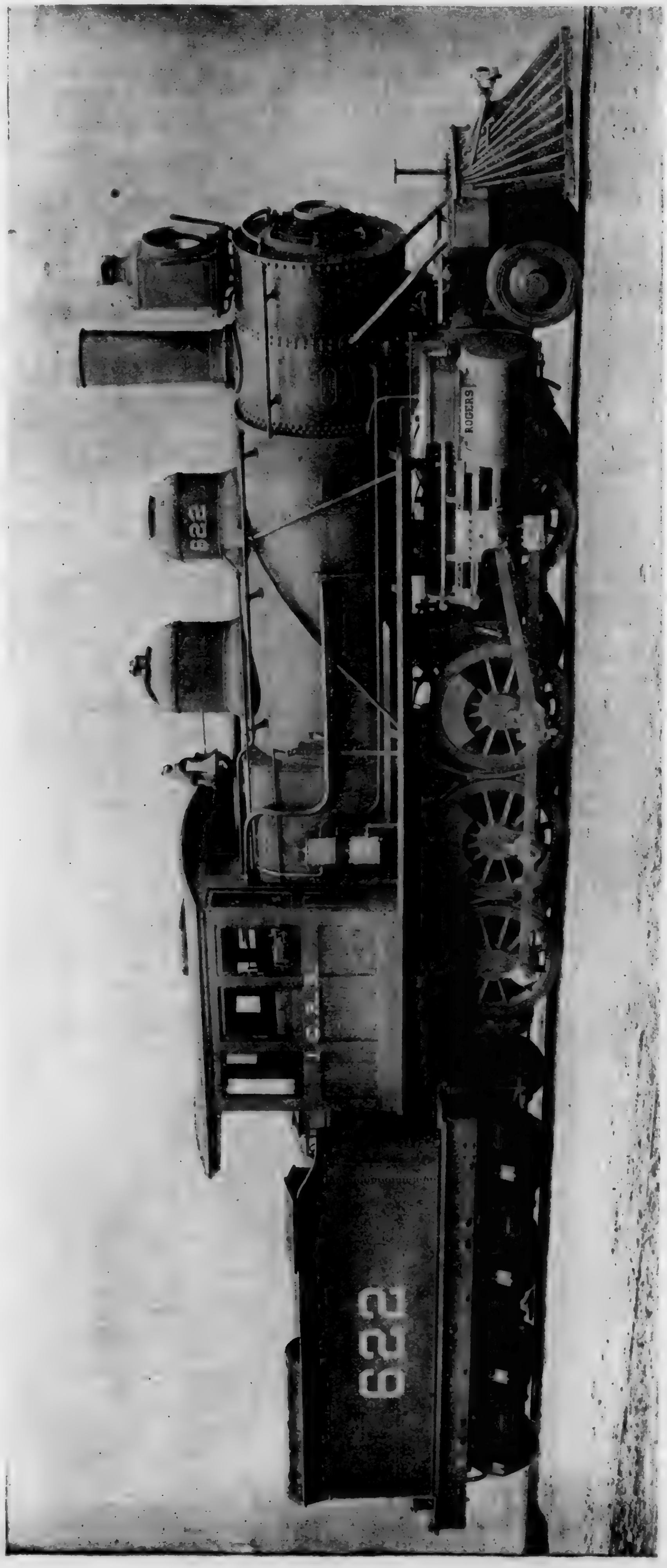
The lines of road comprising the Pennsylvania system are divided into 21 districts, called Medical Examiners' Districts, and are in charge of 35 medical men. At places where very large numbers of employés reside, or in districts containing a large mileage, several medical examiners are stationed. In the Philadelphia office, near Broad Street Station, are three, one or more of whom is on duty day and night. There are also three in the Pittsburgh office, and two each at Jersey City, Trenton, Baltimore, Columbia, Harrisburg, Williamsport, Kane, Lewistown, Altoona and Derry. At other places but one is stationed. In addition to cases occurring in the towns in which these offices are located, medical examiners are required to report on cases of disabled members residing along the lines of the road that may be included in their districts.

The amount of benefits paid to members vary according to the amounts of their contributions. Thus, if a man pays a monthly contribution of 75 cents, he is entitled to 40 cents per day if disabled by sickness for a period of one year, in which time he would receive $146. If his disablement is caused by an accident he is entitled to 50 cents per day for a period of one year, in which time he would receive $182.50, and after the expiration of the year, as long as the disablement may continue, even if it be for 50 years, he is entitled to 25 cents per day. If death should occur during disablement, whether by sickness or accident, the beneficiary receives $250. These figures are all the lowest. If the member contributes a larger amount each month, sick and death benefits are correspondingly increased. The largest amounts of benefits paid are: for sickness, $1.20 per day; for accident, $2.50 per day; and for death, $2,500. During the continuance of disablements contributions are not payable.

Since the commencement of the operations of the Relief Department—early in 1886—more than $1,996,183 have been paid to disabled employés who were members of the Relief Fund, to widows, orphans and other beneficiaries of members who have died.

The method of collecting contributions is better than in any of the mutual benefit societies which are to be found everywhere, because a member always has his contribution made on the pay-roll, never giving him any thought or trouble. As soon as he signs his application his contributions commence without any attention on his part, and he is always "beneficial." Members of other beneficial orders are often deprived of benefits because their assessments have not been paid. The Relief Department has made a great improvement in this matter.

The principal office of this Department is in Trenton, N. J., where the Superintendent's office is located. Both the Superintendent, Mr. J. A. Anderson, and the Assistant Superintendent, Mr. Holmes D. Ely, are railroad men of much experience.



CONSOLIDATION FREIGHT LOCOMOTIVE FOR THE ILLINOIS CENTRAL RAILROAD.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

A NEW CONSOLIDATION FREIGHT LOCOMOTIVE.

THE accompanying illustration is from a photograph of a freight engine of the consolidation type, one of a number recently built by the Rogers Locomotive & Machine Works at Paterson, N. J., for the Illinois Central Railroad.

The boiler is 62 in. in diameter at the smoke-box end; it has 236 tubes 2 in. in diameter and 11 ft. 10$\frac{5}{16}$ in. long. The fire-box is of the Belpaire type, the inside fire-box having no crown-bars, being supported by radial stays extending to the outer crown-sheet. The fire-box is 33 in. wide inside and 10 ft. 2 in. long; it is 71$\frac{1}{4}$ in. deep at the front and 62$\frac{1}{4}$ in. at the back end. The heating surface is: Fire-box, 171 sq. ft.; tubes, 1,482 sq. ft.; total, 1,653 sq. ft. There is a fire-brick arch in the fire-box, supported by studs. The fuel used is soft coal; the usual working pressure is 165 lbs. The grate area is 28 sq. ft. The boiler is fed by two No. 9 Monitor injectors.

The engine has eight driving-wheels connected and a two-wheeled swing-bolster truck. The driving-wheels are 56$\frac{1}{2}$ in. in diameter, the wheel centers being 49$\frac{1}{2}$ in. and the tires 3$\frac{1}{2}$ in. thick. Six of the driving-wheels have flanged tires; the main drivers have plain tires 6$\frac{1}{4}$ in. on the face. The driving-axle journals are 8 in. in diameter and 9$\frac{1}{2}$ in. long. The truck wheels are 33 in. in diameter, and have wrought-iron centers and Krupp steel tires. The driving wheel-base is 16 ft. 9 in., and total wheel-base is 24 ft. 5 in.

The cylinders are 21 in. in diameter and 24 in. stroke. The valve motion is of the ordinary shifting link type; the eccentrics have 5$\frac{1}{2}$ in. throw. The main steam pipe is 8 in. in diameter. The steam-ports are 1$\frac{1}{4}$ × 18 in., and the exhaust-ports 2$\frac{1}{4}$ × 18 in. The guides are of the double-bar pattern, with under-hung cross-head.

The engine is fitted with the Westinghouse automatic brake for tender and train, and has the American driver brake. The engine springs are the Pickering make. The U. S. metallic packing is used.

The weight of the engine light is 123,670 lbs. Ready for service it weighs 137,300 lbs., of which 118,600 lbs. are carried on the driving-wheels and 18,700 lbs. on the truck.

The tender is carried on two four-wheeled trucks; the tender axle journals are 4$\frac{1}{4}$ in. in diameter and 8 in. long. The tank will hold 3,850 gallons of water.

The engine is an excellent type of recent practice for heavy freight work.

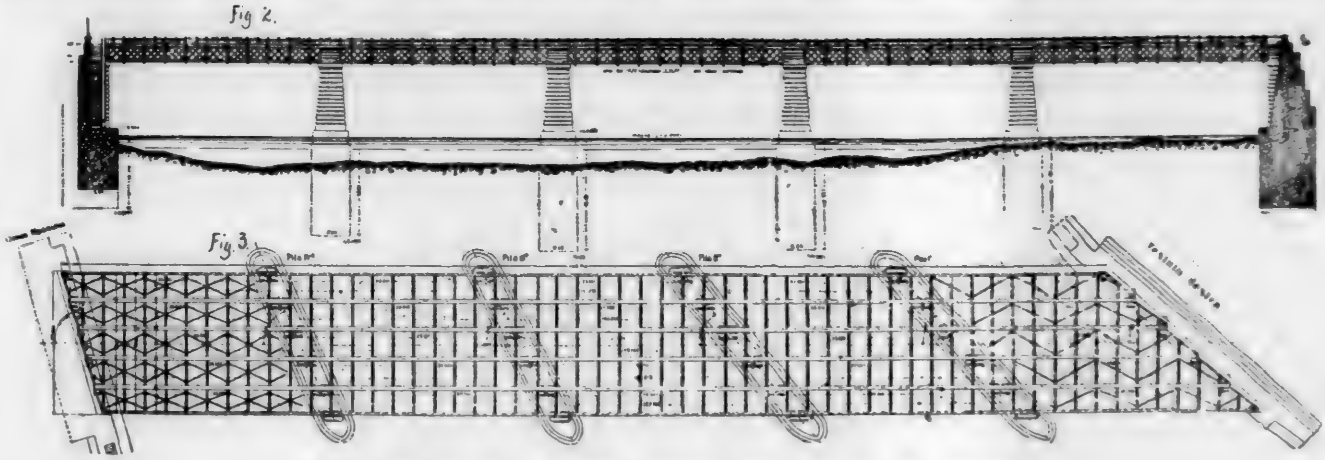
THE PALATINE BRIDGE AT ROME.

IN the improvements made by the Italian Government since Rome became the capital of the kingdom, it has been necessary to replace some very ancient structures by modern ones. Among these is the Palatine Bridge across the Tiber, which was lately completed, and which is described in a very interesting paper read by the Engineer Pietro Bonato, before the Italian Society of Engineers and Architects; from this paper the article below is condensed.

The ancient structure, which was known at various periods as the Palatine, the Senatorial and the Rotto Bridge, has a long and interesting history. It is recorded by Titus Livius that a bridge over the Tiber existed at this spot in the year 192 B.C., and it is not improbable that it was the first one built across the river. At any rate, on this site was built the first stone bridge, which was begun under the Censor M. Fulvius in the year 179 B.C., but was not completed on account of many delays until 151 B.C., under the consulate of P. Scipio and L. Mannius. During the 28 years, however, the work was solidly done, for it kept its place until 208 A.D., when it was partly rebuilt by the Emperor Probus. Nothing more is recorded until 1230 A.D., when it was partially destroyed by a flood, and a new or partly new bridge was ordered built by Pope Gregory XI. Some two centuries later it was again partly wrecked, and was rebuilt under Pope Julius III. in 1552, when no less a person than Michelangelo Buonarotti was concerned with the plans. In 1575, and again in 1598, it was necessary to rebuild the structure in part after heavy floods in the Tiber, but from the last-named year until 1854 it stood unharmed. In that year part of the ancient structure fell, and was replaced by an iron suspension bridge.

Fig. 2.

Fig. 3.



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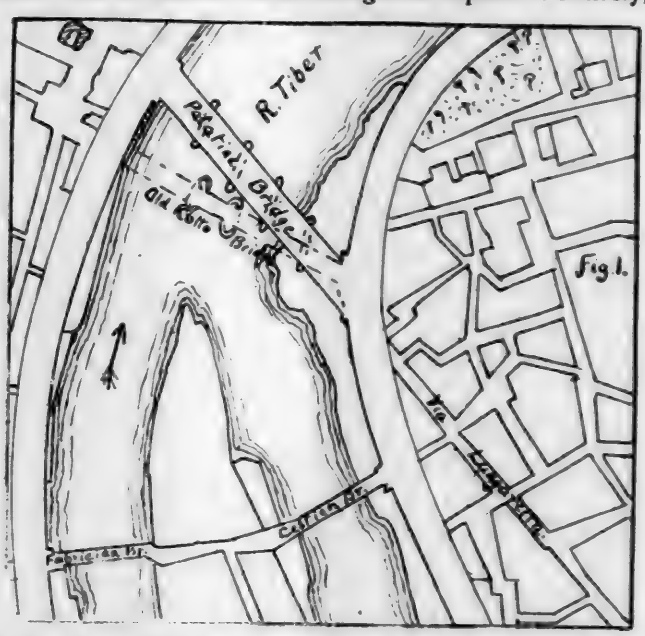

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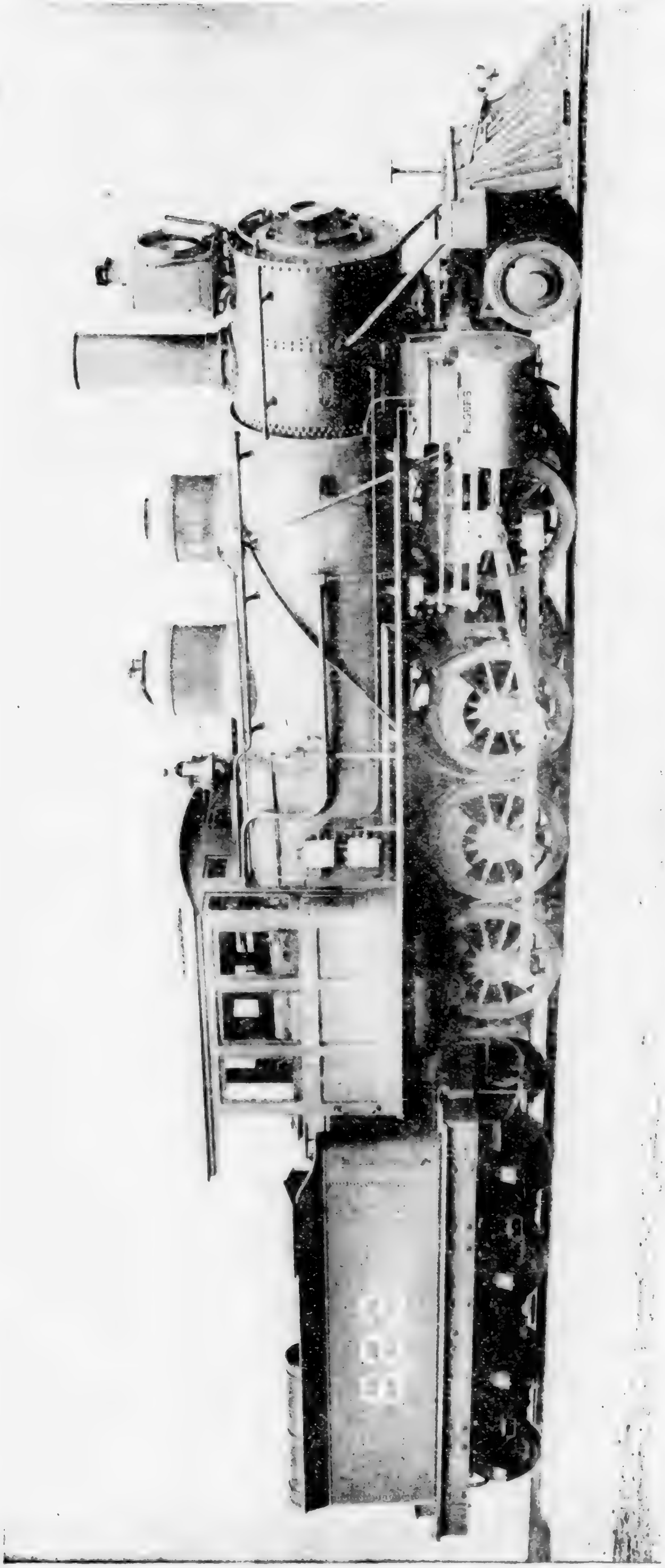

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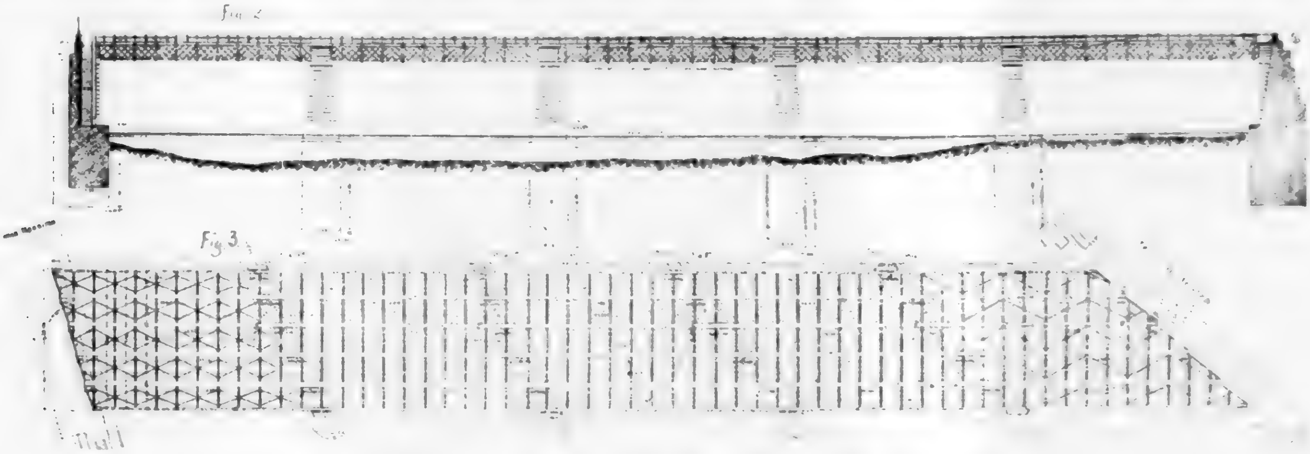

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the new structure being upon a slightly different site, in order to open up a more direct line of communication between the streets on the opposite sides of the Tiber. The

change in site is shown in fig. 1 herewith, which is a map giving the position of the bridge.

As shown in this map, the bridge crosses the river at an angle, although its general direction is nearly at right angles to the course of the stream below the bend, the beginning of which is indicated. In order to present the least possible resistance to the floods for which the Tiber is noted, and also to interfere as little as possible with boat navigation, the piers were placed at a considerable angle to the axis of the bridge.

In order to keep the piers as nearly as possible at right angles with the current, each was placed at a different angle. The angles made by the axis of the bridge with the axes of the several piers is: Right abutment, 41° 38′; first pier, 48°; second pier, 50° 33″; third pier, 62° 17′; fourth pier, 65° 46′; left abutment, 74° 18′.

The bridge itself is a continuous lattice girder, 506.50 ft. in length on the center line. It is supported on two abutments and four piers, being thus divided into five spans, the lengths of which, measured on the center, are: 98.25 ft.; 104.25 ft.; 101.75 ft.; 104.25 ft.; 98 ft.

The piers and abutments are of Maddalena granite, and are founded on caissons sunk through the mud and silt of the river bottom to a solid foundation. The caissons are rectangular in form and are made of iron; they were sunk by the pneumatic process and filled in with concrete. The depth to the bed-rock varied, and the distances to which the several caissons were sunk, measuring from the ordinary water level, was: Right abutment, 33.6 ft.; first pier, 33.4 ft.; second pier, 52.4 ft.; third pier, 56.0 ft.; fourth pier, 46.3 ft.; left abutment, 36.8 ft. The depths below the river bed varied from 17.2 to 36.6 ft. A general elevation and plan of the bridge are shown in figs. 2 and 3.

The caissons for the abutments are both 26.3 ft. in width; those for the four piers are all 18 ft. in width, but vary in length from 99.4 to 121.6 ft. The piers are all 16.4 ft. in width on the bottom course, but vary slightly in length. The shape adopted was to oppose as little resistance as possible to the current, which is very strong in time of floods. No protection against ice was needed, as the Tiber does not freeze.

The superstructure consists of four main trusses of the riveted lattice type spaced 13.4 ft. between centers, and two outside trusses of lighter construction under the sidewalks; the centers of these are 12.1 ft. from those of the outer main girders. The two middle main girders are 7.3 ft. in depth; the two outer main girders 7.9 ft., and the light outside trusses 8.4 ft.

The cross-bracing is shown in fig. 4, which is a half cross-section of the bridge on a larger scale. The water and gas pipes are carried under the sidewalks on brackets, as shown at *A* and *B*. The floor-beams are also shown in fig. 4; at the outer ends they are covered by ornamental caps of cast iron, and support the posts for the hand railing.

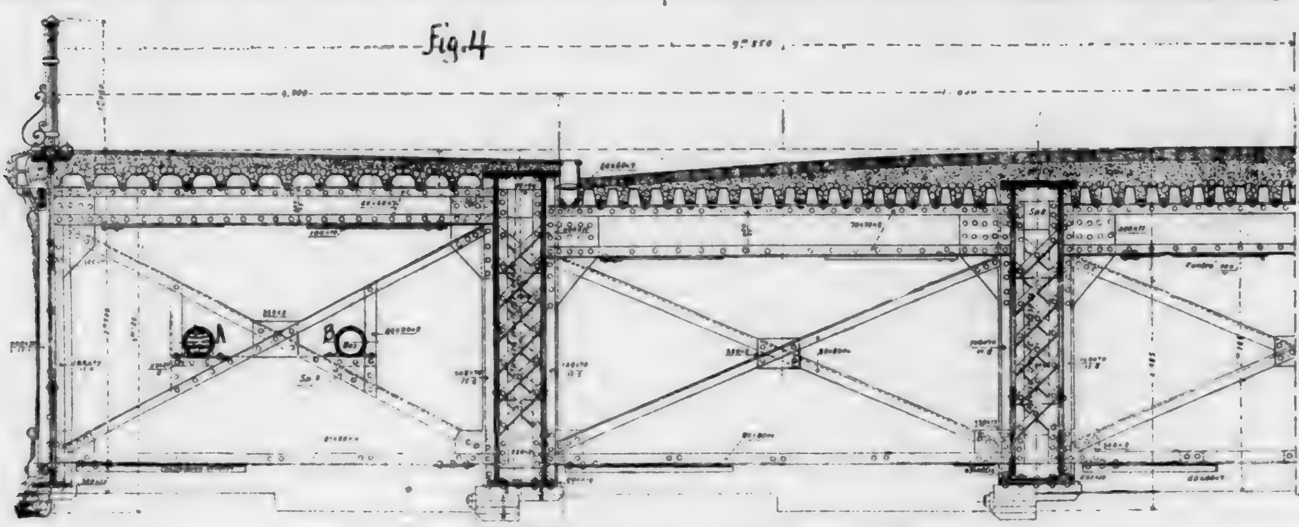
The bridge has a main roadway 51.5 ft. in width, and two sidewalks, each 6.5 ft., making the total width between the railings 64.5 ft. For the roadway the floor-beams carry a system of troughs of iron, shown in section in fig. 4; these support a bed of gravel on which the paving blocks are laid. The sidewalks are of asphalt, laid on a bed of gravel resting on sheet-iron plates with large corrugations, as also shown in section in fig. 4. Proper gutters are provided at the edge of the roadway for carrying off rain-water.

At the left end of the bridge a staircase is formed in the abutment, by which foot-passengers can descend to a landing stage, also formed in the abutment, just above the usual water level.

In designing this bridge regard had to be taken of the works in progress for regulating the Tiber; this determined to some extent the location of the piers. The general location was so made as to continue the Via Lungaretta across the river in a straight line, doing away with the awkward turn required in crossing the old bridge, while at the same time it was necessary to avoid any interference with the temples of Vesta and Fortuna, at the left-hand end of the bridge. This has been successfully accomplished.

Similar difficulties, however, have been encountered everywhere in the extensive works now being carried out by the Italian Government and the Municipality of Rome. Many changes were necessary to improve the sanitary conditions, to make Rome a city of modern appliances, and to provide properly for its increasing population; but at the same time there has been a constant effort to preserve all the ancient monuments which give the city its historic interest.

It may be added that Signor Bonato's paper is accompanied by detail drawings, strain-sheets and full calculations, making a very complete account of the structure under consideration.



THE PALATINE BRIDGE OVER THE TIBER.

ENGINEERING FOR LUMBERMEN.

(Paper read by Mr. A. J. Teed, before the Michigan Engineering Society.)

ENGINEERING for lumbermen, so far as its special features are concerned, is a growth almost entirely of the last 10 years. Fifteen or 20 years ago the lumbermen of Northern Michigan had very little use for a surveyor. In fact, the less they saw of one, the happier they were. Land was cheap; timber was cheap; and no one wanted to know where his lines were, nearer than the landlooker could show him; and as for the engineer, they had no use for him. As timber increased in value, so increased the anxiety of the lumberman to get every tree that belonged to him; and he knew too well by experience the consequences of taking a tree that he did not own; hence accurate land surveying has taken the place in the woods of the guess-work methods of 20 years ago.

A dozen years ago the logs were mostly hauled on the snow over well-graded and finely constructed sleigh roads, the laying out and construction of which, though well and neatly done, required no greater skill than was to be found in any well-regulated lumber camp.

That is all changed now; most of the timber to-day is hauled over logging railroads, often from 25 to 30 miles in length.

In new counties also, around the mills, villages spring up. The lumberman's engineer, in connection with laying out a railroad and mill site, is often called upon to stake out a town. I have not unfrequently been required to survey land, run railroad lines, and stake out village lots, all in the same day, and with the same set of instruments.

THE EMPLOYER.

The engineer usually has very little to do with the proprietor of the timber. Sometimes he does not even see him. The man the engineer has to deal with is the general superintendent. This man is usually intelligent, well posted in his business, a good judge of human nature, and withal a very pleasant man to deal with.

In all minor details, the engineer is generally left to the exercise of his own judgment. But the superintendent has a very definite idea of what he wishes to accomplish, and he can very quickly tell whether or not his engineer is equal to the emergency. It is useless for an inexperienced fraud to impose himself upon the superintendent of a lumbering firm. His inability will very soon be discovered, and he will be invited to move on to another job.

CHARACTER OF THE LUMBERMAN'S ENGINEER.

The lumberman's engineer must be a thoroughly competent land surveyor, always ready for any emergency, and must never make any mistakes. In railroad matters, the engineer must not only understand the principles of locating a railroad, but he must be well posted in the peculiar requirements of a logging railroad. He must know what grades and curves are admissible; how much it will be advisable to expend in grading his road; and how he can reach the timber so that it can be the most economically moved.

He has not only to consider the route as to the cheapest and best place to build a railroad, but he must also consider how the logs can be the most economically placed on the cars. It is not always the cheapest railroad to build that is the cheapest for lumbermen. The expense of getting the logs on the cars is often more than that of hauling. A difference of 5 cts. per M. on skidding and loading will often pay for building a long piece of road.

I laid out a road for a Manistee lumberman last summer where a difference in cost of 5 cents per M. in getting the logs to the mill would amount to over $10,000. We had a choice of three routes, and the problem was not only to decide which of the three routes would take the logs most economically to the river, but as there would be a difference in the cost of driving the logs on the river and of hauling the supplies to the camps, according to which route was taken, this also had to be considered.

The pine lay in a belt two or three miles wide, and about eight miles long, parallel with the Manistee River, and about five to six miles distant. It was necessary to look over this whole tract of country both with a view of determining the relative cost of building the road, and of hauling the supplies by the different routes. We solved the problem, but we were greatly facilitated in doing so by the stubbornness of a Dutchman who stoutly refused to allow us to build the railroad over his valuable piece of sand.

The lumberman's engineer must know many things not found in the books, and many things that he can learn only by experience; and that experience is too often learned at the expense of the lumberman.

KIND OF TOOLS NECESSARY.

In going to and from his work the engineer has frequently to ride 30 or 40 miles in a buggy over a rough road, and it is convenient not to be loaded down with any more tools than are absolutely necessary. For this purpose a light transit with level attachments and a good needle is the best instrument; with this one can do any kind of work required, and it is not convenient to be encumbered with two instruments. A 100-ft. chain is the best for measuring. It is well to carry along a tape to be used when accuracy is required. As the assistants furnished are always inexperienced men, it is necessary to use a self-reading rod, which for the sake of portability should fold up to a length not greater than 7 ft. or 8 ft. and be capable of being extended to 12 ft. or 16 ft.

About all the other tools absolutely required are a pocket compass, a hand level, a pocket set of drafting tools, a supply of profile paper, a little quinine, and a good supply of oil of tar. The last article is sometimes quite as necessary as the transit.

METHODS OF WORK.

In methods of work, engineering for lumbermen possesses these characteristics: *First*, that the work be rapidly done. No puttering or fussing over some ideal nicety can for a moment be tolerated. *Second*, while the work does not require extreme accuracy, the engineer, like Gillespie's needle, must never be very wrong. The work must be done on correct principles. A good needle line and chain measurement, if the method is correct, will never get the lumberman or his engineer into any trouble. The engineer must go fast and go right. Unlike farm lines, the lumberman makes no attempt to perpetuate his lines and corners after the timber is cut. As soon as the timber is removed the fire runs through the woods and soon obliterates all traces of the survey. The Government corners, of course, should be carefully perpetuated; but it is not worth while to spend much time on the interior corners. They can be better set when they are wanted, if they ever are.

In railroad building I generally commence my work by taking a pocket compass, a hand level, one assistant with an axe, and look the country carefully over, blazing those places that seem to be the proper places for the railroad. When I have thus gained a general idea of the country, I run a random line where it appears to be the best ground, and take a level on it. And then, in the evening, so as not to take the time of my assistants, I construct from the notes of my random lines, if the grades are satisfactory, a set of notes from which I can locate my line just where it is wanted, with no further calculations than can be made mentally in the field.

In running the random lines I note all those places where the line must pass, and in locating run the curves with reference to these points.

For example: suppose I have been running a 4° curve, and when I get around parallel with my next tangent I find I am 10 or 20 ft. to one side; instead of going back and re-running the curve, I note what change in the course of the tangent would be necessary to carry me through the next pass. I then lengthen or shorten my curve sufficient to make the requisite change in the next tangent and go ahead. For this work I find a good set of traverse tables very convenient. After my line is located I take my levels, and that is often the last I ever see of it.

Except in rare cases no cross-section or calculation of earthworks is ever made. Nothing but the center line is staked out; of this I furnish the foreman of the camp a profile with the cuts and fills for each station marked on in figures, and the foreman or his grader works out the line with no further assistance from the engineer.

GRADES AND CURVES.

As to what grades and curves are admissible on a logging railroad it is difficult to give accurate data, so much depends on the circumstances. The engineer must find out what kind of engine it is proposed to use, how much pine it will be necessary to haul in a day, the total amount of pine to go over the road, and, lastly, the size of his proprietor's pocket-book; for frequently the lumberman does not think himself able to build such a road as the engineer might think the most economical.

As to curves, any curve on a steep up-grade is very objectionable; and a sharp curve at the foot of a steep downgrade should always be avoided. If a train gets to slipping down a steep grade with a sharp curve at the foot, it is very liable to jump the track. A 4° curve on the whole

is a very good curve; it is not so sharp as to be objectionable, and is very easy to run. From that up to 8° or 10° will be allowable where there is not much grade. For a direct-action engine on the main line I would never put in a curve sharper than 8° or 10°, and never sharper than 4° or 5°, unless the nature of the ground requires it. With a geared engine, when the ground requires it, a 16° curve can be worked over with perfect safety by running slow.

On a road where I did some work an engineer put in a 16° curve at the foot of a long grade where it was desirable to run rapidly. The ground was level, and a 2° or 3° curve could have been laid as easily as the one he laid. More accidents have happened on that curve by engines and cars jumping the track, not to speak of loss of time in being obliged to slow up the train in going around the curve, than the time of the engineer was worth for a year.

In regard to grades, so much depends on the character of the engine used that no definite rules can be given. And yet it is often very desirable to know just what can be done in particular cases.

This can be answered best by giving a few examples of what has been actually done, and leave the engineer to draw his own conclusions in his particular case.

With regard to engines, the Shay geared engines will haul a greater load over a hill than any other form with which I am acquainted, but they are slow. I have seen one of these engines, about 12 tons, haul 2 to 3 cars up a 4 and 5-ft. grade and handle 6 to 8 cars down a 5-ft. grade with no accidents. This same engine has for the last two years been successfully working a train of 15 cars on a long down grade of 2.2 ft. They have never had any accidents since the track was properly ballasted, but I do not think it would succeed if the grade were over 2½ ft.

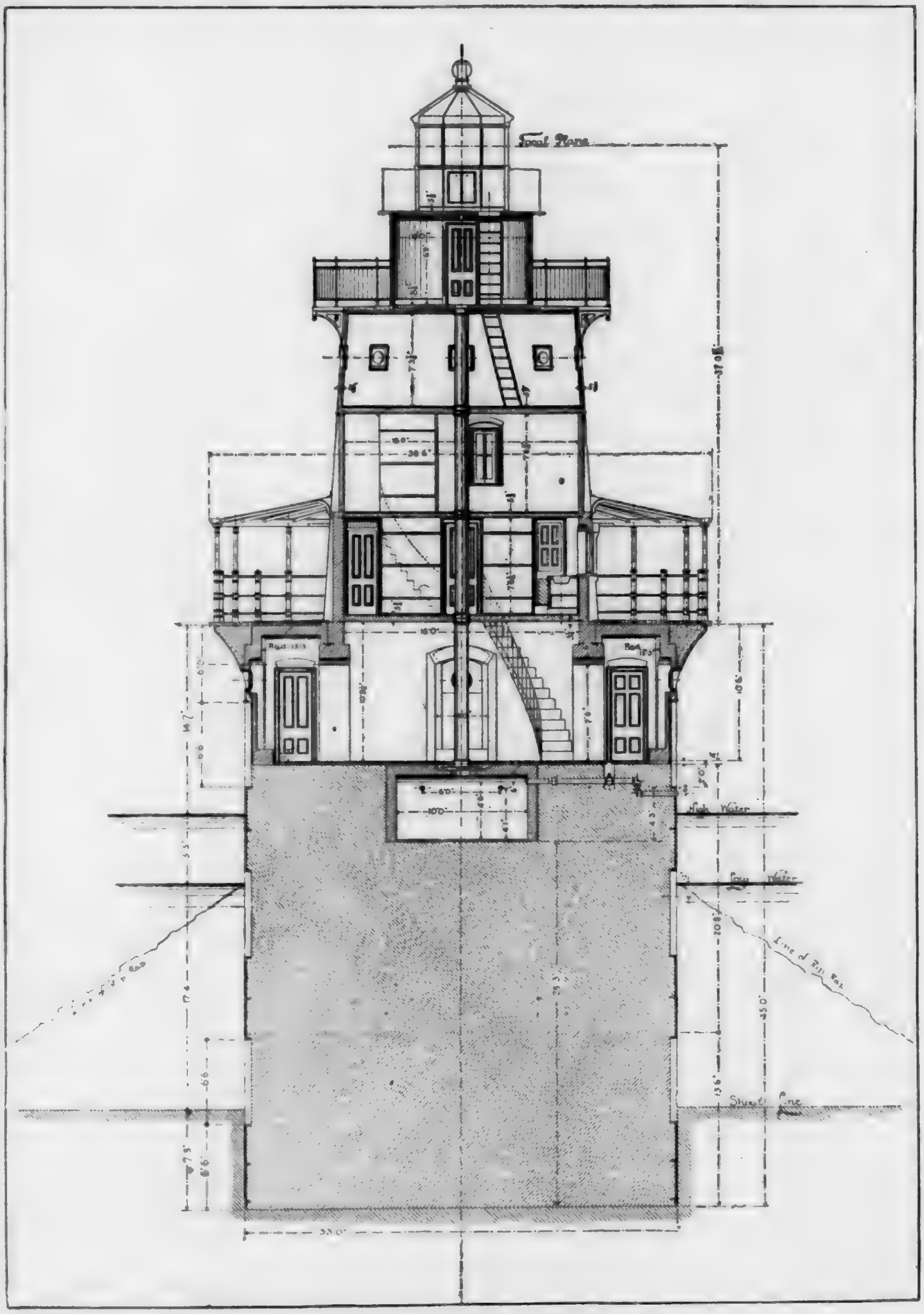
Another of the geared engines of 7 tons pulled all the pine of a half section over a hill where the grades run from 6 to 9 ft. in 100; but it could not haul over one or two cars, and sometimes not that. When the track was wet, the down grades were not safe, and they had a good many accidents. One of these engines will do very good work switching over hills of 4 to 5 ft., but on the main line, when a full train is to be hauled, the grades should be less than 2 ft. up and 2½ down.

On another road, where they use a 12-ton Porter engine, there is a grade of 1 ft. with a 4° curve at the top; total raise, 20 ft. The regular train is 15 cars, but when the track is wet the engine cannot make the top of the hill without taking a run of at least half a mile. On this same road with a 14-ton Porter engine they can haul up a 1-ft. straight grade 30 cars when the track is dry, but will sometimes stick with 20 cars when the track is wet. But on a 1.6-ft. straight grade this same engine makes two trips for 18 cars.

On another road a Boulehis engine, 22 tons, hauls 6 to 8 cars up 3-ft. grades for its regular trains. I have seen a 19-ton Mogul engine haul 10 cars up a 2½-ft. grade at the rate of 8 miles per hour, but this same engine in trying to come up a 4-ft. grade with 3 cars slipped and went to the bottom.

The best work of which I have any accurate data is being done on a road that I surveyed this summer. This road goes over a hill 150 ft. high. The last 1,200 ft. of the up-grade is 3 ft. per 100. The first half of the down-grade is 2 ft. and the last half is 3 ft. per 100, with two 16° curves. Over this hill a Shay geared engine of 30 tons on the drivers, with three 10 × 10-in. cylinders, is daily drawing 15 cars of 2 to 3 M. feet each. This engine can draw 2 cars up 27 ft. in 300.

These cases which I have cited are all extremes, and to be recommended only when the necessity of the case requires it. My rule is to keep the track as near the surface of the ground as I can for economy's sake; but I never put in any curves or grades that I do not know are perfectly safe without first consulting my employer.



LIGHT HOUSE FOR OLD ORCHARD SHOAL.

THE OLD ORCHARD SHOAL LIGHT-HOUSE.

THROUGH the courtesy of Major D. P. Heap, U. S. Engineers, the Engineer of the Third Light-house District, we have received the plans and specifications of the light-house shortly to be built on the Old Orchard Shoal. These plans and specifications are unusually full, giving the work down to the minutest details, and the drawings are especially good and complete. We regret that we have not the space to present more of them here.

The accompanying illustration, which is reduced from Plate 1 of the specifications, is a section through the center of the structure, and shows the general form and construction, with the principal dimensions.

Old Orchard Shoal, on which the light-house is to be built, is situated in New York Lower Bay. The site selected for the light-house is on the southern extremity of the shoal, about 5⅜ nautical miles N. W. ¼ W. from Sandy Hook Main Light, in a minimum depth of 17½ ft. at low water. The tides at this place have a mean rise and fall of 5½ ft. Borings made at the site show that the surface of a stratum of fine gravel, upon which the foundation pier is to rest, lies at a depth of 7 ft. 8 in. below the surface of the shoal, being covered by a mixture of sand, small shells, and mud.

The structure will consist of a circular foundation pier, supporting a three-story circular dwelling, a veranda with boat-davits, a circular parapet, and an octagonal lantern. The foundation pier is to be a cast-iron cylinder, open at both ends and trumpet-shaped at the top. It is to be sunk 7 ft. 8 in. into the bottom of the bay. The lower portion of the cylinder is to be filled with concrete, and will contain the water cisterns. The upper portion is to be lined by a brick wall, and its interior space, the cellar, is to be divided, by one circular and a number of straight brick walls, into various compartments for the storage of oil, fuel, provisions, etc. The annular space between this brick lining and the circular wall is to be covered by brick arches, which will carry the main gallery floor. The main gallery, which will be accessible from the water by ladders, is to be covered by an iron roof and surrounded by handrails, which, like the boat-davits, are to be attached to the columns supporting the gutter on the outer edge of the roof. The iron dwelling will have the form of a frustum of a cone; it will rest upon the circular wall of the cellar, and is to be divided into three stories by three iron floors, which are to be supported by the brick linings of the house and center columns. The dwelling is to be covered by an iron gallery floor, which will support the parapet, the watchroom floor, the lantern gallery, and the lantern. A spiral stairway of iron will lead from the cellar to the different floors of the dwelling. The watchroom and the lantern will be accessible by ladders.

The shell of the foundation pier is to be of cast-iron; it will be 33 ft. in diameter at the base, 37 ft. 9 in. at the upper end and 45 ft. in height. This cylinder will be composed of 224 plates, arranged in seven courses of 32 plates each, with ribs and lugs by which they are bolted together. The plates of the lowest course will be made with a cutting edge. This cylinder when in place will be filled in with concrete to a depth of 34 ft. 2 in., and on top of this will be the circular wall forming the foundation of the light-house proper, and enclosing the cellar. The water cisterns will be formed in the concrete.

The tower will have the shape of a frustum of a cone, and will be 21 ft. in diameter at the base, 18 ft. at the top and 24 ft. high. It will be of cast-iron plates in three courses, the first course having 15 plates, the others 16 each. The door jambs, lintels and window-sills will be also of iron. The whole structure, in fact, will be of iron, the only wood used being for doors, flooring and trimmings.

The lantern will be octagonal in form, 7 ft. 1½ in. in diameter and 10 ft. 11 in. in height. It will contain lighting apparatus of a high order.

The different stories of the tower will be arranged as a light-keeper's dwelling, and will be provided with all necessary conveniences. Storage for oil, fuel and provisions, and cisterns for fresh water will be provided in the foundation.

The light-house will stand in the bay, at a point some distance from land, and will be accessible only by boat. While in great part sheltered, and not open to the full force of the ocean, as are some of our light-houses, there is sometimes a heavy sea in the Lower Bay, and the structure requires considerable strength to meet it.

The drawing given shows very well the general character of the light-house, and the method of construction will be readily understood.

The bids received for the work on this light-house were as follows, for the metal work: John P. McGuire, Cleveland, O., $15,760; Russell Wheel & Foundry Company, Detroit, Mich., $15,850; Allentown Rolling Mills, Allentown, Pa., $18,307; Phœnix Iron Company, Trenton, N. J., $19,438; Allentown Foundry & Machine Company, Allentown, Pa., $19,950; A. W. Colwell & Company, New York, $20,800; Wheeler Condenser & Engineering Company, New York, $23,500; Cockburn Barrow & Machine Company, New York, $49,850.

For the erection, the bids were: J. H. Hathaway & Company, $23,500; S. W. Frescoln, New York, $32,000; John Cox, Brooklyn, N. Y., $33,940; Sooysmith & Company, New York, $34,000; Howell & Chapman Company, New York, $34,730; Anderson & Barr, Jersey City, N. J., $48,000; Frank Bruschler, Edgewater, N. J., $54,413; Finn & Hayden, New York, $85,000.

CLASSIFICATION OF PIECE-WORK ON LOCOMOTIVES.

(*Continued from page 82.*)

WE conclude below the classification of locomotive piece-work, which was begun in the January number. As then explained, this classification is that which has been adopted for the shops of a leading railroad, in which new construction as well as repair work is done, and is for an eight-wheel passenger locomotive. In use it is made out in table form, the columns of the table containing the name of the piece and the work and the price paid, per piece, pair or set. It has not been thought necessary to use this form here, the object being to show the division and classification of the work only:

TENDER TRUCK.

Molding Pedestal.
" " Guide.
" Journal Box.
" " Wedge.
" Brake Block.
" " Shoes.
" Chafing Casting.
" Channel Liners.
" Truss Saddle.
" Brake Bar Casting.
" Bolster Plate.
Forging Brake Shoe Hanger.
" " " " Key.
" Steel Axle, 4½ × 8.
" Release Spring.
" Axle Guard.
" Live Lever.
" Dead "
" Fulcrum Bar.
" Round Lever Guard.
" Flat " "
" Top Arch Bar.
" Bottom Arch Bar.
" Brake Beam Safety Yoke.
" Spring Seat.
" Safety Chain Eye Bolt.
Cutting off Truck.
Dressing "
Boring "
Mortising "
Gaining "
Drilling Release Spring.
" Axle Guard.
" Live Lever.
" Dead "

Drilling Fulcrum Bar.
" Top Arch Bar.
" Bottom Arch Bar.
" Brake Beam Safety Yoke
" Flat Lever Guard.
" Spring Seat.
Cutting off Axle.
Turning Axle.
Boring Wheels.
Fitting up Wheels.
" " Journal Box.
" " Standard Tender Truck.

ENGINE TENDER.

Molding Bolster Plate.
" Chafing Casting.
" Coupling.
" Push Pole Casting.
" Truss Stands.
" Washers.
" Chafing Casting, A 16.
" Steps.
" Knees.
" Keys.
Forging Truss Rod.
" Compound Bolster Plate.
" Safety Chain, Left.
" " " Right.
" " " Hooks.
" Body Truss Rod Washer.
" Drag Chain Hooks.
" Push Pole Hanger.
" Tie Rod.
" Stay "
" Truss Rod Strap.
" Safety Chain Strap.
" Brake Shaft.
" " " Hanger.
" " " Holder.
" " " Stand.
" " " Eye Bolt.
" " Lever Stirrup.
" " Equalizing Bar.
" Hand Brake Lever.
" Push Rod.
" Cylinder Brace.
" Connecting Rods.
" Lever Guard.
Cutting off Tender Frame.
Dressing " "
Boring " "
Mortising " "
Tennoning " "
Gaining " "
Drilling Compound Body Bolster Plate.
" Body Truss Rod Washer.
" Push Pole Hanger.
" Truss Rod Strap.
" Safety Chain Strap.
" Brake Shaft.
" " " Hanger.
" " " Holder.
" " " Stand.
" " Lever Stirrup.
" " Equalizing Bar.
" Hand Brake Lever.
" Push Rod.
" Cylinder Brace.
" Connecting Rod.
" Lever Guard.
Boring Coupling Casting.
Turning " Pin.
" Gooseneck Feed Pipes and Nuts.
Fitting up " " " " "
" " Hand Railing.
Making Push Pole.
" Coal Boards.
" Front Tool Box.
" Back " "
" Standard Tender Frame.

Building Tank, Complete.
Putting " on Frames.
Fitting up Engine and Tender with all Iron Pipe Work, Complete.

PAINTING.

PILOT.

1st Coat Lead.
2d " "
Putty and Glaze.
Sand-paper.
3d Coat Lead.
Sand-paper.
1st Coat Black.
2d " "
Varnish.
Rub down.
Stripe.
Finishing Varnish.

FRAMES, FIRE BOX AND TRUCK.

Cleaning.
Coat Black.
Varnish Black.

BOILER.

Coat Metallic Brown.

CYLINDERS, AIR-TANKS, LIFTING-SHAFT, ROCKERS, BUMPER AND BACK CASTINGS.

Cleaning.
Coat Red Lead.
1st Coat Iron Filling.
Putty and Glaze.
2d Coat Iron Filling.
3d " " "
Sand-paper.
1st Coat Black.
Varnish Black.
Rub-down.
Stripe.
Finishing Varnish.

DRIVING AND TRUCK-WHEELS.

Cleaning.
Coat Red Lead.
1st Coat Iron Filling.
Putty and Glaze.
2d Coat Iron Filling.
3d " " "
Sand-paper.
1st Coat Black.
2d " "
Varnish " "
Rub-down.
Stripe.
Finishing Varnish.

WHEEL-GUARDS.

Cleaning.
Coat Red Lead.
1st Coat Iron Filling.
Putty and Glaze.
2d Coat Iron Filling.
3d " " "
Sand-paper.
1st Coat Black.
Varnish "
Rub-down.
Stripe.
Finishing Varnish.

SMOKE-BOX.

Coat Oil Black.

HEAD-LAMP.

Rub-down.
Stripe.
Finishing Varnish.

STACK, SAND-BOX, BELL-STAND AND DOME.

Cleaning.
Coat Red Lead.
1st Coat Iron Filling.
Putty and Glaze.
2d Coat Iron Filling.
3d " " "
Sand-paper.
1st Coat Black.
2d " "
1st " Varnish.
Rub-down.
Stripe and Letter.
2d Coat Varnish.
Rub-down "
Finishing "

HAND-RAILS AND ALL PIPES.

Coat Black.
Varnish Black.

CAB.—EXTERIOR.

1st Coat Lead.
Sand-paper.
2d Coat Lead.
Putty and Glaze.
1st Coat Filling.
2d " "
3d " "
Guide Coat.
Block down.
Sand-paper.
1st Coat Black.
2d " "
1st " Varnish.
Rub-down "
Stripe and Letter.
2d Coat Varnish.
Rub-down "
Finishing "

CAB.—INTERIOR.

Staining.
1st Coat Varnish.
Putty.
2d Coat Varnish.

SASH.

Staining.
1st Coat Varnish.
Putting in Glass.
2d Coat Varnish.
3d " "

ROOF.

Cleaning.
1st Coat Metallic Brown.
2d " " "

TENDER TRUCKS.

Cleaning.
1st Coat Lead.
Putty and Glaze.
Sand-paper.
2d Coat Lead.
Sand-paper.
1st Coat Black.
Varnish "
Stripe.
Finishing Varnish.
1st Coat Varnish Black, on inside of Trucks.

TENDER FRAME.

Cleaning Iron Work.
1st Coat Lead.
2d " "
Putty and Glaze.
Sand-paper.
3d Coat Lead.
Sand-paper.
1st Coat Black.
2d " "
Coat Varnish Black.
Stripe.
Finishing Varnish.

TANK.

Cleaning.
1st Coat Lead.
2d " "
Putty and Glaze.
1st Coat Filling.
2d " "
3d " "
Guide Coat.
Blocking-down.
Sand-paper.
1st Coat Black.
2d " "
1st " Varnish.
Rub-down "
Stripe and Letter.
2d Coat Varnish.
Rub-down "
Finishing "

TENDER-BOXES.

Coat Dark Lead Color.
Putty.
1st Coat Varnish Black.

COAL SPACE AND TOP OF TANK.

Coat Metallic Brown.

It will be seen that this classification is very full and even minute, so that it can well be used as a pattern. It is the only one we have ever seen in which the painting is included in all its details.

RAILROADS IN NICARAGUA.

A RECENT report from Consul Newell, at Managua, to the State Department, says that since the completion of the Government Railroad of Nicaragua in 1887, there had been little activity in railroad matters until a short time ago, when English capitalists became interested in the concession granted to the Nicaragua & Atlantic Railroad Company. This road is now in course of construction from San Ubaldo, on the eastern side of Lake Nicaragua, nearly directly opposite to Granada, to Rama, a point about 60 miles distant from the Atlantic Coast.

The chain of the Nicaraguan Andes dividing the lake basin from the Rama River, lies between the head-waters of the Oyale, passing La Manga, and the Rama River. Here is the most difficult and broken portion of the line. The Portilla del Cascal, where the line crosses the divide, is probably the lowest and most favorable for the purpose, as the ground height of the summit is 713 ft. above the Atlantic.

A portion of the route, 60½ miles in length, will be very heavy, owing to the excessively broken character of the country traversed. The total length of the line is 102½ miles, of which five-sixths are fairly easy and one-sixth difficult. The line crosses the important rivers San Agostin, Acoyapa, Ajocuapa, de Aguas, Cacao, Oyale, Chilmate, and Serrano, the two latter being tributaries of the Rama, none, however, exceeding 180 ft. in width.

The line surveyed is certainly as good as could be selected through the country for gradients, curves, and cost. It is the intention to complete the road within three years and at an estimated cost of between $3,000,000 and $4,000,000. The gauge of the road will be 3 ft. 6 in., being the same as that of the National line.

The company also intends to deepen the channel at the mouth of Bluefields River. When this is done, vessels of 12 ft. to 14 ft. draft can go up the river to Boca de la Rama, 65 miles. The country along the river is well

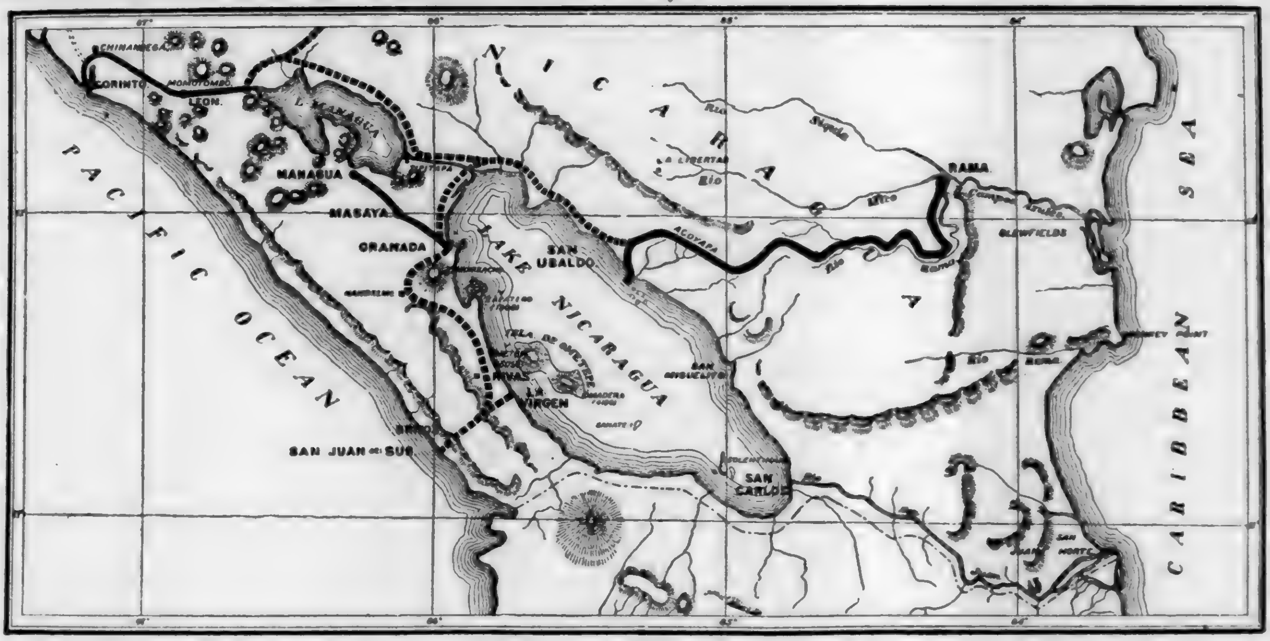
GUNBOAT "PETREL," UNITED STATES NAVY.

settled and cultivated. The country along the proposed line abounds in mahogany, cedar and other valuable woods, and in India-rubber trees.

A railroad has just been built from San Jorge on the western shore of Lake Nicaragua, to Rivas, 3 miles. It carries both passengers and freight, but the motive power at present is furnished by mules.

The Government of Nicaragua has in contemplation a railroad from Momotombo, on the northwestern side of Lake Managua, to Sebaco, in the department of Matagalpa. The length of the proposed road is 120 miles.

This proposed road will tap a section that is destined in a near day to be the coffee-producing district of Nicaragua. There are a large number of foreigners already in this department, many of them Americans, and each year sees the number largely augmented.



Besides the roads in construction, there are a number projected, as follows: From Chinandega to El Viejo, a distance of 4 miles; from San Juan del Sur to San Jorge, the extent of the line being 22 miles.

San Juan del Sur is the second port of importance on the Pacific Coast in Nicaragua, while San Jorge is a shipping point on the western side of Lake Nicaragua. This contemplated road will run through a section of country that is being fast settled up and greatly needs advanced means of transportation.

A road is also being projected from Masaya to Jinotepe, a distance of 20 miles.

The accompanying map shows the railroads now in existence in Nicaragua, and also those in course of construction.

The statements in this summary do not include the railroad lines which the Canal Company is building, from San Juan del Norte to Ochoa, 32½ miles, and from Brito to Rio Lajas, 16½ miles. These are intended chiefly to aid in building the canal.

THE GUNBOAT "PETREL."

THE accompanying illustration is from an excellent photograph of the United States gunboat *Petrel*, one of the smaller vessels of the new Navy. While of course not equal in weight or fighting power to the larger cruisers, this ship is one of a class which is very useful on several of the foreign stations and very efficient; while in case of war these vessels might prove excellent auxiliaries to the larger boats.

The *Petrel* was built under contract by the Columbian Iron Works in Baltimore. The contract was let in December, 1886, and the vessel was finally accepted by the Navy Department in October, 1889. Since then she has been in commission in service of different kinds, and is now on her way to join the China squadron, for service in which she is particularly adapted.

The general dimensions of this vessel are: Length between perpendiculars, 175 ft.; beam, 31 ft.; depth of hold, 15 ft. 7 in.; mean draft, 11 ft. 7 in.; displacement, 870 tons. She has three masts, with a barkentine rig, and a considerable spread of canvas. The hull is of steel, and is divided by nine transverse water-tight bulkheads. The engine and boiler space is surrounded and covered as completely as possible by the coal bunkers, which are divided into compartments, which can be separately flooded and drained. Further protection is afforded by a steel deck ⅜ in. thick, which curves from a height of 8 in. above the water-line at the crown to 2 ft. 6 in. below at the sides.

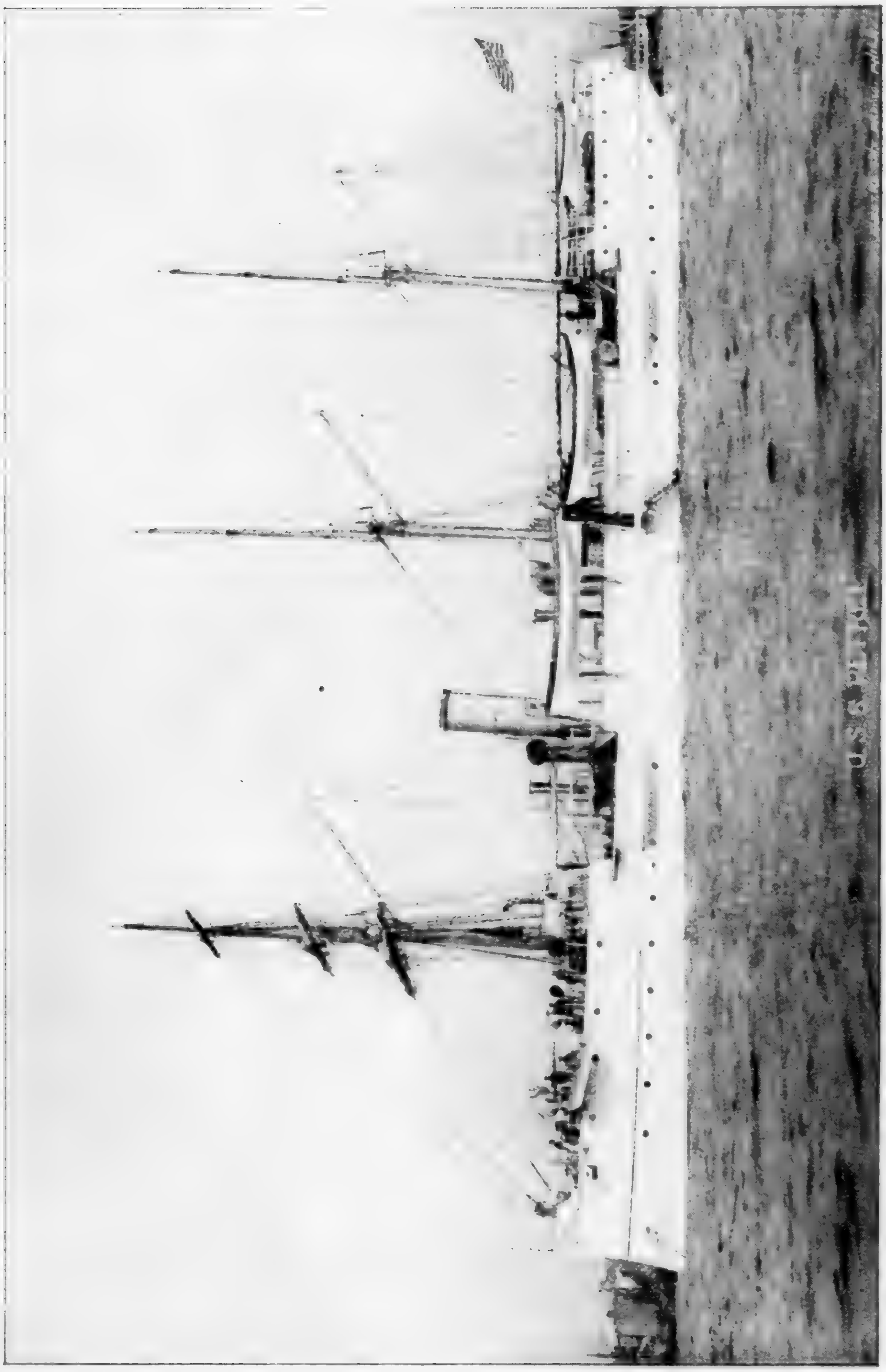
The armament consists of four 6-in. breech-loading guns, mounted in sponsons, two on each side, at a height of 10 ft. 8 in. above the water-line, and fitted with segmental steel shields. The forward pair is just abaft the break of the forecastle, the after pair just forward of the break of the poop, having clear bow and stern fire. The platforms on which these guns are mounted are raised 4 ft. above the spar-deck. The secondary battery includes two 6-pdr. rapid-fire guns, and two revolving cannon. The armament is a heavy one for a ship of this size.

The *Petrel* is propelled by a single screw; it is three-bladed, 9 ft. 9 in. in diameter, with a mean pitch of 12 ft. 3 in. The screw is driven by a two-cylinder horizontal compound engine, with cylinders 25 in. and 46 in. in diameter and 33 in. stroke. Steam is furnished by two cylindrical boilers 8 ft. 8 in. in diameter and 18 ft. 4½ in. long. The total grate area is 83 2 sq. ft., and the heating surface 2,796 sq. ft. On a four-hours' trial trip, with 89 lbs. pressure in the boilers, the engines developed an average of 1,095 H.P., and the average speed was 11.8 knots. Under forced draft the maximum power developed was 1,513 H.P.

The *Petrel* left New York last on November 3 and reached Port Castries, Santa Lucia, November 12. Thence her course was eastward, and she reached Gibraltar December 7; left there December 12, and arrived at Port Said December 20. A stop of 10 days was made there, and she then continued on her voyage, and has probably reported to the Admiral of the Asiatic Squadron by this time. She was reported at Singapore on February 2.

The voyage across the Atlantic was a very stormy one, but the *Petrel* proved herself an excellent sea boat. The engines worked well, and the only change found desirable was the fitting of an additional ventilator, which was done during the stop at Port Said.

The *Petrel* carries a crew of about 100. The ward-room is comfortably fitted up, although rather confined in size, and the general appointments are good. The ship has an electric lighting plant on board, and is wired for lights throughout.]



GUNBOAT "PETREL," UNITED STATES NAVY.

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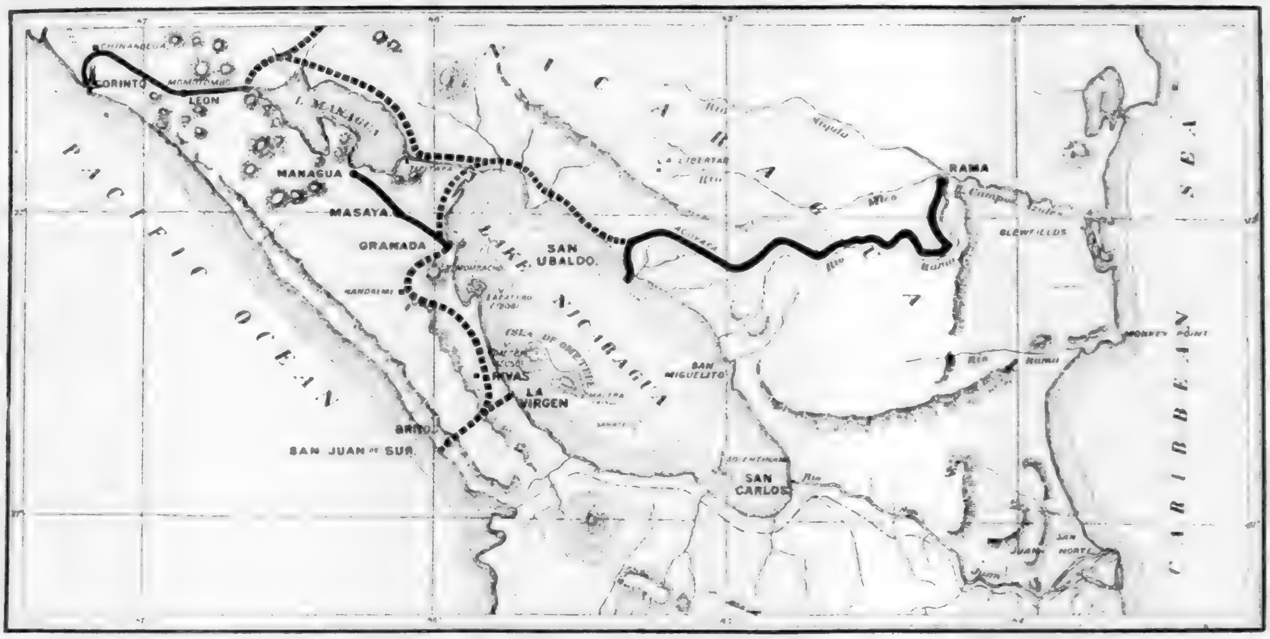

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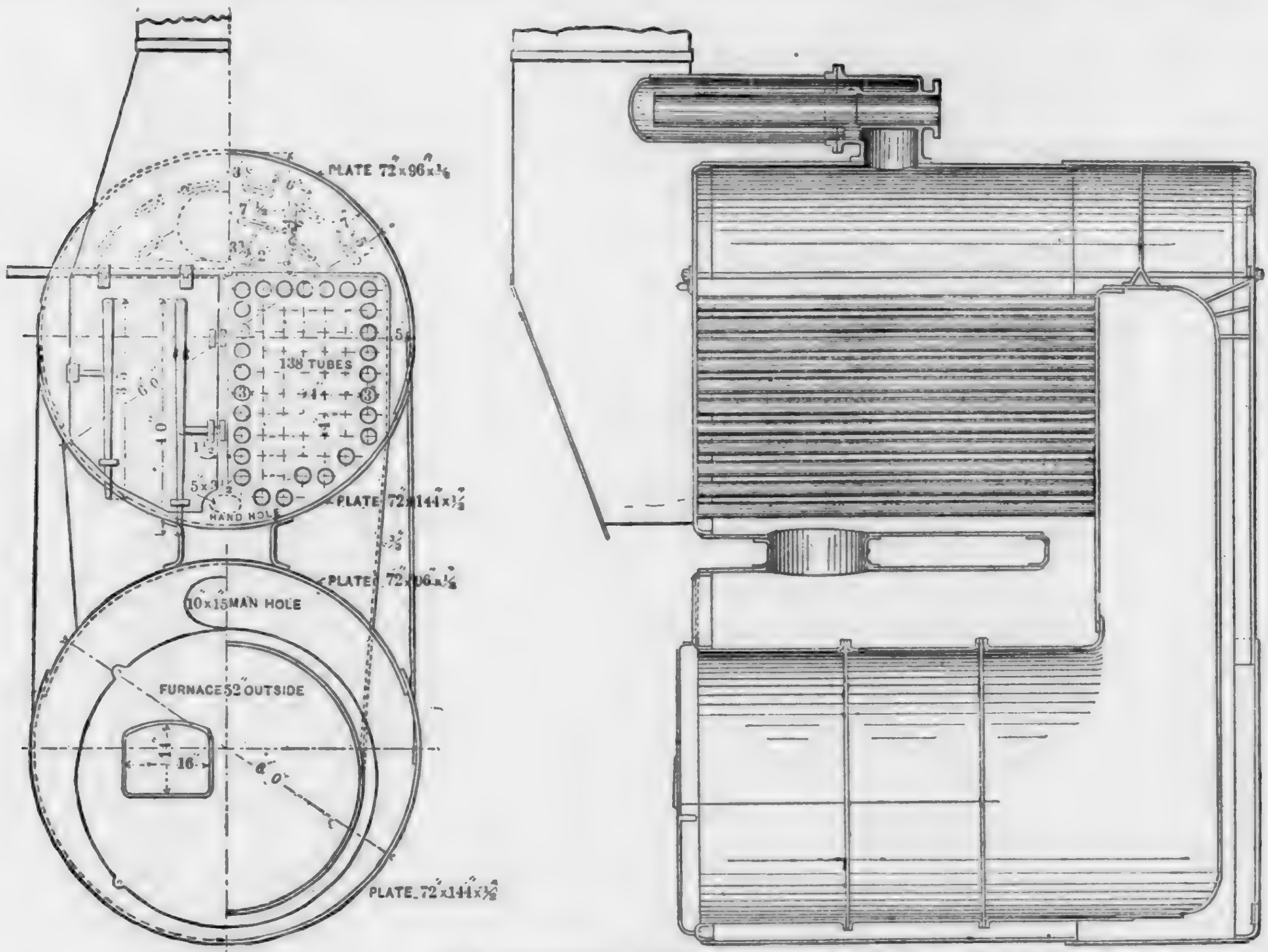
THE DUNDON COMPOUND BOILER.

THE accompanying illustration, for which we are indebted to *Industry*, San Francisco, shows a boiler devised and built by Mr. P. F. Dundon, of that city, for which remarkable economy has been shown. It has been in use for some time in several buildings in San Francisco, and one has also been in use on the tug *Astoria*. An economy of 30 per cent. over the boilers replaced is claimed by the inventor. In the Lagrange laundry an experiment made showed an evaporation of 9.7 lbs. of water to 1 lb. of Franklin coal; the feed-water was 120°, and the steam consumption was too slow to give the best results.

This form of boiler, it may be added, is patented by Mr. Dundon. The smaller types require no masonry in setting them. It is, in effect, a high-class internally fired boiler, with ample water and steam rising surface. The construction is very completely shown in the drawings.



THE DUNDON STEAM BOILER.

The boiler represented is in use in Huntington, Hopkins & Company's building in San Francisco. The lower shell, which contains the furnace, is 72 in. in diameter, and the upper shell, which contains the return flues, is also 72 in. in diameter. The combustion chamber is 24 in. long, 52 in. wide at the bottom and 67 in. at the top, and is 10 ft. high. The furnace is 52 in. in diameter and 6 ft. 6 in. long, made in three sections, flanged out at the ends of the sections with flanges riveted to each other, having a caulking ring of 2¼ × ½-in. Norway iron between. The back end of the furnace is flanged outward to connect with the tube-sheet, thus giving no double thickness of plate and no rivets on any part of the crown sheet. The upper shell contains 138 tubes 3 in. in diameter and 6 ft. 6 in. long.

This boiler is of ½-in. steel of 60,000 lbs. tensile strength, except the back, sides and crown of the combustion chamber, which are of $\frac{7}{16}$-in. steel. It was built throughout with a view to meet the inspection required by the United States laws for marine boilers. If placed in a steamboat it would be entitled to a certificate authorizing the carrying of 135 lbs. steam pressure.

ELECTRICAL TRANSMISSION OF POWER.

(From the *Electrical Engineer*.)

THE electrical event of the year 1891 was undoubtedly the successful accomplishment of the transmission of power by alternating currents of high potential between Lauffen and Frankfort, a distance of some 112 miles. The special committee appointed to test this installation have not yet made their official report, but the interest with which the large body of electrical engineers has followed these experiments is such as to warrant us in bringing forward a preliminary statement of the results obtained at Frankfort, as they appear in an article in the *Schweizerische Bauzeitung* by Mr. Emil Huber, Director of the celebrated Oerlikon Works. According to Mr. Huber, the average potential used in the experiment was 16,000 volts, and only toward the end of the experiment was it increased to 30,000. The fears at first expressed that the oil insulators would not stand this pressure proved groundless, for as an actual fact only a single insulator broke down, and that under a strain of 30,000 volts.

Two other disturbances were caused by the breaking of a wire and by a defective insulator, due to a fault in the manufacture, respectively. It is interesting to note that the cost of the installation per effective horse-power—on the assumption that 300 H.P. was delivered to the line at Lauffen, and that the whole amount of this energy was available in Frankfort—was $300, of which the line itself involved a cost of $210!

But the next most interesting question from the electrical engineer's standpoint is that of the efficiency of transmission obtained in the Lauffen-Frankfort installation.

During the experiments, regular readings were taken at both ends of the line, and voltmeter readings were taken

between one conductor and the neutral point in each of the three circuits, which averaged 54 volts, the currents reading 500, 490 and 500 amperes respectively in the primary circuits. Leaving out of consideration the lag between the current strengths and the potentials, the mean electric power delivered to the line was 80,500 watts. At the same time, the Frankfort end of the line delivered current for 1,060 incandescent lamps of 16 candle power, which absorbed 58,000 watts. According to this estimate, therefore, the installation showed an efficiency of 72 per cent. Mr. Huber, however, points out that in reality the efficiency was actually higher, due to this lag, and he estimates it to be about 5 per cent.

Regarding the doubts which were at one time expressed as to the influence of rain and foggy weather, it was shown that these phenomena had no material influence on the working of the line, no direct leakage to earth having been observed, the instruments showing the same indications both in wet and dry weather; so that, if there actually was such a loss, it was negligible. The losses due to condenser action of the insulators were also found to be but very small. In general it is claimed that no abnormal phenomena were developed in this transmission which could not be calculated and allowed for in advance for any similar installation to be made in the future, and that the losses are similar to those occurring in low-tension systems and which can be determined by Ohm's law.

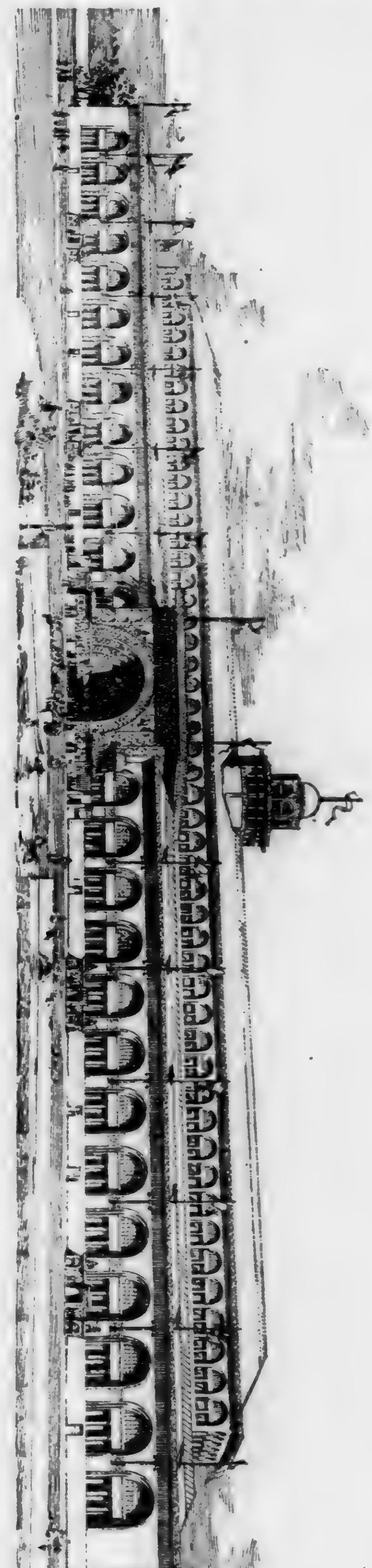
In the absence of the official report of this installation, the results, as stated above, coming as they do from an interested party, must still be considered of a tentative nature, but if they should be substantiated by the official report of the commission, the Lauffen-Frankfort transmission may well claim a high place among modern feats of engineering.

TRANSPORTATION AT THE COLUMBIAN EXPOSITION.

THE illustrations given herewith show two exterior views of the building for the display of exhibits in the Department of Transportation at the Columbian Exposition, a plan of the main floor and a plan of the gallery. This building is located on the western bank of the large lagoon surrounding the wooded island which occupies nearly the center of the Exposition. It is near the main entrance to the grounds and convenient of access. The building is surmounted by a cupola reaching a height of 165 ft. Eight elevators will run from the center of the main floor to balconies surrounding the cupola at heights of 115 and 128 ft. The view from this observatory will give visitors an excellent comprehension of the whole plan of the Exposition Grounds at a glance.

The architects of the building are Messrs. Adler & Sullivan, of Chicago, who are known as the architects of the Auditorium and other buildings. Its general architectural treatment is simple, but with rich and elegant details. The main entrance will consist of an immense arch, decorated with carvings, bas-reliefs and mural paintings. It will be treated entirely in gold leaf and will be known as "the golden door." Numerous minor entrances are provided, as shown in the plans, and with them are grouped terraces, seats, drinking fountains and statues. The interior of the building is treated much after the manner of a Roman basilica with broad nave and aisles. The roof is in three divisions; the middle one rising much higher than the others, and its walls pierced to form a beautiful arcaded clerestory.

The main building covers a space of 960 ft. in length by 256 ft. deep—but as shown in the plans, the main floor includes nearly nine acres of additional space under roof. The total floor space, including the entre-sol, is nearly 17 acres. A 75-ft. transfer-table will traverse the annex, along the western line of the main building. Railroad tracks will be laid in the annex at right angles to the transfer-table. The heaviest locomotives and cars can be run direct from the installation track, which runs alongside the southern end of the building, upon the transfer-table, which will take them to their proper tracks inside the building. The length of these tracks is such that an entire train can be shown connected as when in actual use. When installation of heavy exhibits has been completed, the pit of

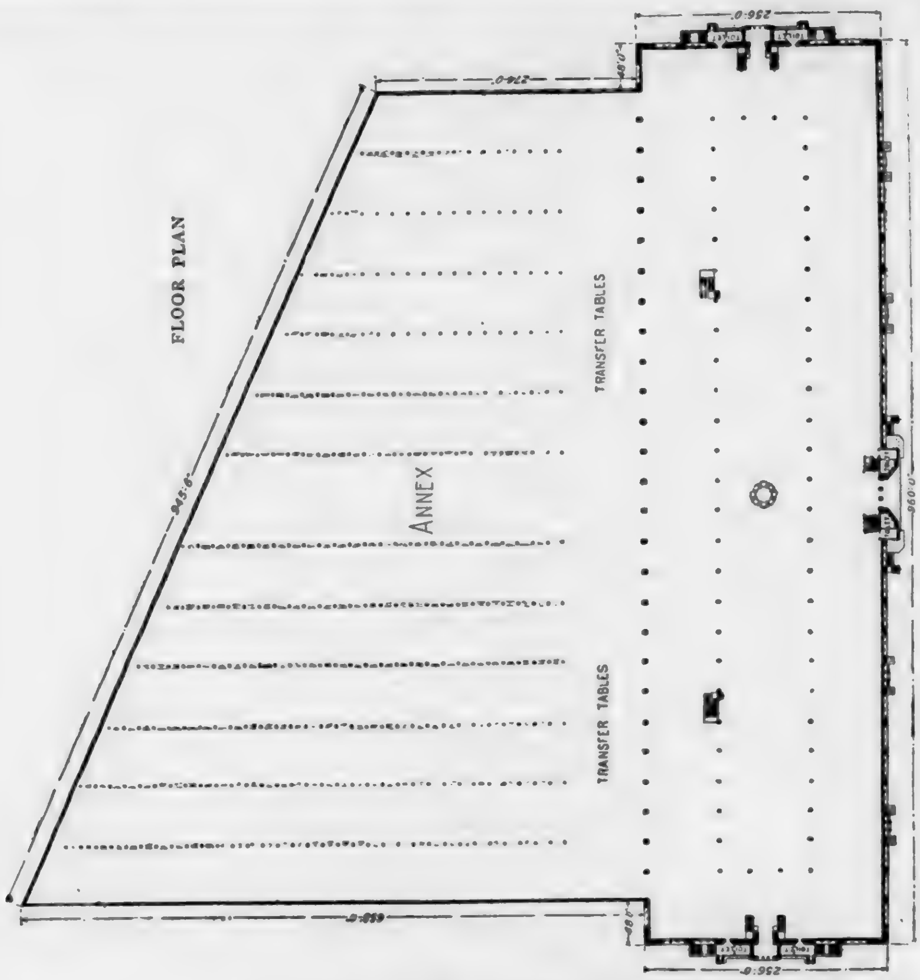


FRONT ELEVATION.

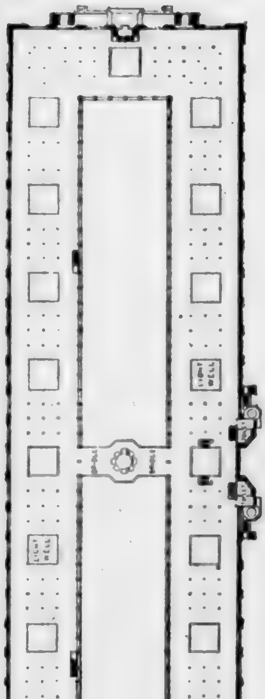
THE TRANSPORTATION BUILDING AT THE COLUMBIAN EXPOSITION.

the transfer-table will be floored over. The annex will open into the main building in such a manner as to afford long and striking vistas down the main avenues and aisles.

TRANSPORTATION BUILDING, COLUMBIAN EXPOSITION.


FLOOR PLAN


SIDE VIEW, SHOWING ANNEX.


GALLERY PLAN.

A space of over eight acres is devoted to the railroad exhibit. The plan adopted provides for the best possible utilization of space. Exhibitors will have every opportunity for showing their appliances and devices to the best advantage. As far as possible, arrangements should be made by joint agreement for showing everything in its proper place and relations. Locomotive appliances can best be shown on locomotives, and the appurtenances and furnishings of cars, on cars. Specimens of standard permanent way will afford opportunity for showing track materials, tools and all that appertains thereto in the best possible manner. It is believed that nearly all of the establishments engaged in locomotive, car and bridge building will be represented. A large number of the leading railroads of the world will also make exhibits of their standard road-bed, track and equipment. The opportunity thus offered for joint action is almost unlimited, and by proper placarding where necessary, every exhibit may be given proper prominence. Abundant and choice space has been designated and reserved for foreign countries; and every possible facility will be afforded foreign exhibitors.

Street Railroads—surface, underground and elevated—are to be shown very completely in this department. Everything relating to their permanent way and equipment is here included, with the single exception that electric motors must be shown in the Department of Electricity. Cars and other supplies for electric roads belong in this department—a division which, while seeming to be arbitrary, is evidently necessary.

A large portion of the floor space of the transportation building proper will be devoted to the display of vehicles for common roads. Included in it, it is hoped to show, with heretofore unequaled completeness, all of the characteristic forms and types of wheeled vehicles, except those used on railroads. The classification is to be closely maintained, and exhibits of this nature from all countries are to be shown together, so that the most interesting and instructive comparisons may be made. Harness, saddlery and horse trappings of all kinds are here provided for. Other vehicles and conveyances, such as those

used on snow, and those employing human muscle as the motive power, are also included in this classification.

Transportation through the air and by means of air is yet in a comparatively undeveloped condition. Whatever is worthy in past achievements may here appear, and whatever there is of present success or future promise. Whether or not this realm is ever conquered by human ingenuity, the subject will always be a fascinating one.

Every known method of transportation on water may be shown in the division of Marine Transportation. Small craft of all kinds may be exhibited in full size—vessels, from the nature of the case, must be shown by models. For fuller illustration, drawings, plans and paintings will be shown. Principal attention will be given to the merchant marine. The navigation of the inland waters of the world, especially the great lakes and rivers, will doubtless be illustrated more fully than in any previous Exposition. The classification provides, also, for everything of interest connected in any way with the subject of navigation. The Government of the United States will make its naval display in connection with its own building. Foreign governments, builders of vessels of war and defense, throughout the world, and manufacturers of naval supplies, are invited to exhibit in this department, and are assured of every consideration. The separate exhibit of the United States Government will not prevent a representation of its naval history and its present plans by means of models, etc., in this department.

The general classification and arrangement of exhibits in the Department of Transportation is given below:

GROUP 80. RAILROADS AND PLANT.

Class 499.—Railroad Construction and Maintenance, including plans, tools, methods and appliances.

Class 500.—Railroad Equipment, including locomotives and cars for passenger, freight and other service, shops for building and repair.

Class 501.—Railroad Operation, including the various departments, train management and organization of employés.

Class 502.—Railroad Management, including accounting departments and organizations for securing and handling business.

Class 503.—History and Statistics. Under this head are included technical associations and technical literature.

GROUP 81. STREET AND SHORT LINE SYSTEMS.

Class 504.—Cable Railroads and Cars.

Class 505.—Electric Railroads and Cars.

Class 506.—Horse Railroads and Cars.

Class 507.—Elevated and Underground Railroads.

GROUP 82. SPECIAL RAILROADS.

Class 508.—Mountain, Gravity and Rack-rail roads, and other miscellaneous roads.

GROUP 83. TRANSPORTATION ON COMMON ROADS.

Classes 509–523, inclusive.—Vehicles for road use of all classes, including not only those drawn by horses, but also bicycles, hand-carts and wheelbarrows.

GROUP 84. AERIAL AND OTHER FORMS.

Class 524.—Transportation of letters and parcels in Pneumatic Tubes.

Class 525.—Shop-fittings for transfer of parcels and money.

Class 526.—Balloon Transportation and Captive Balloons.

Class 527.—Elevators and hoists.

GROUP 85. MARINE, LAKE AND RIVER TRANSPORTATION.

Class 528.—Sailing Vessels and Boats.

Class 529.—Steamships and all vessels propelled by motive power other than sails, oars and paddles.

Class 530.—Vessels, boats and floating structures for special purposes, barges, rafts, canal boats and similar craft and dry docks.

Class 531.—Marine Mechanical Appliances.

Class 532.—Construction, Outfit, Equipment and Repair of Vessels.

Class 533.—Methods of Lighting, Heating, Ventilation and Refrigeration of Ships.

Class 534.—Protection of Life and Property and Communication at Sea.

Class 535.—Wrecking Apparatus.

Class 536.—Miscellaneous.

GROUP 86. NAVAL WARFARE AND COAST DEFENSE.

Class 537.—Armored Vessels.

Class 538.—Unarmored Vessels.

Class 539.—Ships and War-boats of barbarous and semi-civilized nations.

Class 540.—Models and Relics of famous Ships of War.

Class 541.—Training Ships, Naval Schools and Naval Reserves.

Class 542.—Guns and Armor, Torpedoes and other appliances.

The rules of the Department state that power (electric or compressed air) will be furnished for operating such machinery or appliances as can only properly be shown in that manner. No direct steam power will be furnished, nor will any lines of shafting be erected in the building. Electric or compressed air power must be taken direct, and the exhibitor must furnish his own motor for utilizing the same. Steam will be furnished under adequate pressure for testing car-heating and other devices requiring it. The escape of such steam into the atmosphere will not be permitted, and the exhibitor must provide for taking care of condensation.

AN ELECTRIC FORGING PLANT.

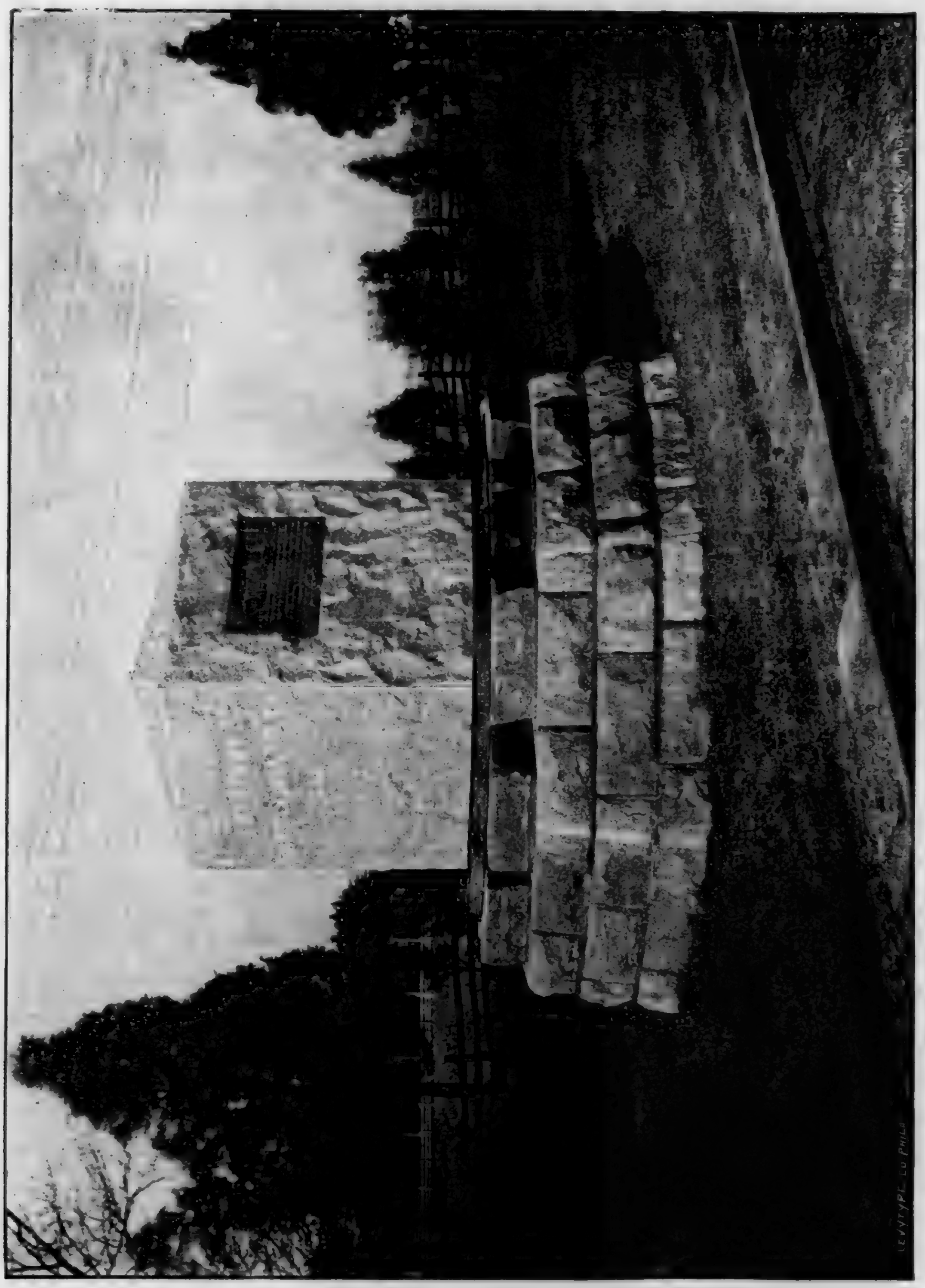
(Condensed from the *Electrical Engineer*.)

AN extensive plant for electrical forging has recently been established in Boston by the Electrical Forging Company, which owns the patents of Mr. George D. Burton. The machinery used is of Mr. Burton's invention. The plan adopted, speaking electrically, is the use of alternating currents in conjunction with large converters capable of developing enormous amperage.

The generating plant proper consists, first, of a 60-H.P. Thomson-Houston motor, which receives its current from the regular street circuits of the Edison Illuminating Company of Boston. This motor is belted to a line of shafting carrying one Emerson power scale with meter attachments for accurate measurement of horse-power consumed. From this line of shafting is driven the 60-H.P. alternating generator, specially manufactured by the Eddy Electric Manufacturing Company, of Windsor, Conn., for the Electric Forging Company, and also a small exciting machine for the fields of the generator. This main shaft also drives a line of shafting which operates all the tools and forging machines both on this floor and in the basement below. The generator is specially wound to develop 24 amperes at 1,500 volts, and the current is controlled by a two-way switch, which throws it either into the converter on this floor or into the converter in the basement. Following the path of the current, it is then brought to a switch and rheostat underneath the converter, and then passed up into a converter suspended on beams from the girders above. This converter is of special design, different from anything before manufactured, and was also made by the Eddy Company. It consists of 14 coils in the primary circuit, through which flows the primary current, and 14 large secondary coils, all of which are connected by special arrangement to the massive positive and negative conductors, which are composed of heavy copper rings, encircling the whole structure.

The converter has a capacity of about 60 H.P., and is designed to deliver current at 5 volts and from 5,000 to 8,000 amperes. From the rings above described, this enormous current is conducted by three sets of heavy copper bars to special electrodes provided with automatic

adjustable clamps, in which the heating of the metals takes place. These electrodes are conveniently situated among machines for rolling balls, rivets and other kinds of regular and irregular shapes, the metal being heated and then passed into the machine. The electrodes are of special design, and vary according to the kind of work to be done. In certain cases where end heat is required, the clamps on the electrodes of one polarity are provided with



THE RAILROAD MONUMENT AT BORDENTOWN, N. J.

1831–1891.

a number of holes, through which a number of metal rods can be inserted, as shown in the figure. When these rods come into contact with the electrode or clamp of the other polarity, they are heated in a few seconds to a forging heat, and while one heated rod is being worked by the rolling machines, the other rods are in the process of being heated, the machines being thus fed with a constant supply of heated metal. The capacity of this converter is about 1¼-in. steel, round or square, and four bars of this size can easily be heated at the same time. A complete outfit, however, has recently been shipped to England, and another to Canada, which will heat bars up to 5 in. square and 3 ft. long, throughout the entire length in about five minutes, with an expenditure of from 75 to 100 H.P.

Passing down-stairs into the basement, there is another 60-H.P. converter with a series of forging machines for doing larger and heavier work than those on the floor above and with a varied arrangement of clamps for special work. This converter has four sets of electrodes with clamps suitable for a varied class of work, and is designed for 2½ volts and from 8,000 to 12,000 amperes, having a capacity of heating to a forging heat a bar 1½ in. square, 20 in. long, in 5½ minutes with an expenditure of 42 H.P. In one case the set of electrodes has been specially

designed to get an end heat on a bar of given size, and is also suitable for heating a bar throughout its entire length up to 24 in.; other electrodes are provided for heating spring steel, and for moving rods, bars, etc. A set of electrodes of extra heavy copper 3 in. in diameter, for heating large stock for heavy forgings, is placed between two heavy drop hammers, one of them capable of giving a blow equal to 60,000 lbs., so that with the proper dies any kind of forging can be readily made. There are also special sets of clamps for transverse currents, so that bars of metal can readily be heated in the middle of their length or at any desired place in their length. There are a number of different machines for varied kinds of rolling and forging, including Bradley hammers, various punches, presses, rolling machines, machines for making balls for ball bearings, for rough and fine grinding, and a 10-ton machine for heavy forgings such as railroad coupling-pins, king-bolts, etc.

The shop is also well equipped with fine tools for the manufacture of all kinds of dies and the manufacture of the heavy copper clamps and conductors used on the converters. On the main floor is situated conveniently a draughting-room, where the drawings for the special machinery are made, and designs for applications to special purposes are carefully elaborated.

In order to give a better appreciation of what can be done by this process, a few cases may be cited:

1. A round bar of tool steel, ⅞ in. diameter and 11 in. long between the clamps, is raised to the proper forging heat in one minute by 32 H.P.

2. A flat bar of machinery steel, ¼ in. thick, 1 in. wide and 17 in. long, is heated in one minute by 34 H.P.

3. Balling stock for balls, tool steel ½ in. diameter and 5 in. distance between the clamps, is heated in half a minute by 27½ H.P. This heat can be maintained for any length of time, by means of a perfect controlling apparatus, the heat on the metal during that time remaining perfectly constant.

4. A bar of machinery steel 1 in. square and 12 in. long, is brought to a white heat in 2½ minutes by 36 H.P.

Taking the last case for an example, and 2 lbs. of coal as a fair average per hour per horse-power, we have 72 lbs. of coal used per hour for the 36 H.P., which is equal to a consumption of about 3 lbs. of coal for the 2½ minutes.

One of the great advantages of the electric system of heating lies in the evenness with which the metal is heated, the interior of the metal being heated first, and then extending uniformly and gradually over the whole mass. By this means objects can be forged by the electric process in one heat, which before required two or three heatings in furnaces. Owing also to the even heating, the metal forgings are much more reliable, the metal being subjected to no unequal strain either in heating or cooling. The quickness with which any piece of metal is heated by the electric current is also advantageous in many cases, as a few inches back from the part under treatment the metal is quite cool and can be conveniently handled. Probably one of the greatest advantages, however, lies in the fact that during the process of heating there are no gases developed, nor is there any foreign substance present to enter into the metal. So that whether the metal be iron, steel, brass or composition, after being heated electrically it is entirely without scale.

The economy of electric forging is a subject well worth studying, and a few of the claims urged for this process may be here enumerated. First, there is the economy of space, no provision having to be made for large furnaces, and consequently more room can be allotted to the metal-working machines. Then there is great economy in the fuel, as the fuel, instead of being scattered in a number of different forges is concentrated in one boiler furnace. There are also no ashes to be withdrawn from forges, nor fuel to be brought to them, thereby effecting a large saving in time and labor. The simplicity of the machine is another factor in its favor, it being extremely easy to operate and keep under perfect control, and after a few pieces of metal of a certain size have been heated, the machines can be set to act perfectly automatically and without any skilled assistance.

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IN the number of the JOURNAL for December, 1891, page 540, an account of the dedication of the Railroad Monument at Bordentown, N. J., was given. The sketch then presented, although it showed the form and design of the monument, was hardly an adequate representation, and we take the opportunity of presenting to our readers an excellent engraving, for which we are indebted to the courtesy of the *Pennsylvania Railroad Men's News*.

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IRON PRODUCTION IN 1891.

(From the *Bulletin* of the American Iron & Steel Association.)

THE American Iron & Steel Association has received from the manufacturers complete returns of the production of pig iron in the United States in 1891, and also complete returns of the stocks of unsold pig iron in the hands of pig-iron manufacturers or their agents at the close of the year.

The total production of pig iron in 1891 was 9,273,455 net tons of 2,000 lbs., or 8,279,870 gross tons of 2,240 lbs., against 9,202,703 gross tons in 1890—a decrease of 922,833 gross tons, or over 10 per cent. The decreased production may be said to have all occurred in the first half of 1891, as the production in the second half of 1891 was larger than in either half of 1890. The production in each half of 1890 and 1891 was as follows, in gross tons:

YEARS—GROSS TONS.	First Half.	Second Half.	Total.
1890	4,560,513	4,642,190	9,202,703
1891	3,368,107	4,911,763	8,279,870

Our production of pig iron in the second half of 1891 was 269,573 gross tons larger than in the second half of 1890, which was the half year of largest production in our history prior to 1891. Our production in the second half of 1891 was at the rate of 9,823,526 gross tons per annum. It was larger than in any full year in our history down to and including 1885, and larger than Great Britain's production in any whole year down to and including 1867. Our production of pig iron in 1891 was about 1,000,000 gross tons larger than that of Great Britain in the same year.

The production divided according to nature of fuel used in the furnaces was as follows, in net tons, spiegeleisen being included:

FUEL USED.	1891.	1890.
Charcoal	646,200	703,522
Anthracite Coal	2,090,041	2,448,781
Bituminous Coal and Coke	6,537,214	7,154,725
Total	9,273,455	10,307,028

The shrinkage in production in 1891 as compared with 1890 was distributed among the different fuels used in our blast furnaces, and it was shared by most of the pig-iron-producing States in the North and West, most notably by Pennsylvania, which lost over half a million net tons, all

adjustable clamps, in which the heating of the metals takes place. These electrodes are conveniently situated among machines for rolling balls, rivets and other kinds of regular and irregular shapes, the metal being heated and then passed into the machine. The electrodes are of special design, and vary according to the kind of work to be done. In certain cases where end heat is required, the clamps on the electrodes of one polarity are provided with 1¼-in. steel, round or square, and four bars of this size can easily be heated at the same time. A complete outfit, however, has recently been shipped to England, and another to Canada, which will heat bars up to 5 in. square and 3 ft. long, throughout the entire length in about five minutes, with an expenditure of from 75 to 100 H.P.

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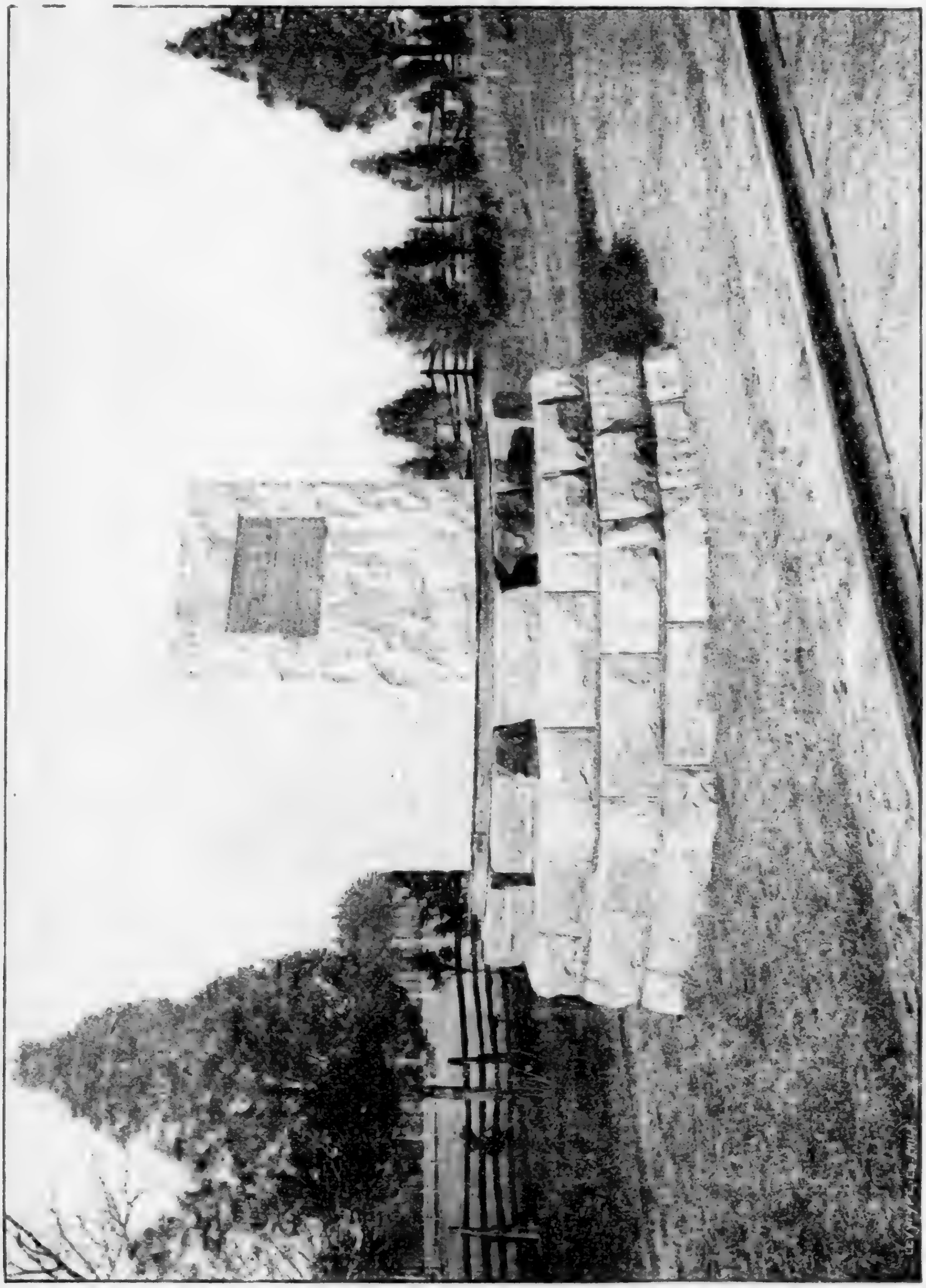

THE RAILROAD MONUMENT AT BORDENTOWN, N. J.

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Years—Gross Tons.	First Half.	Second Half.	Total.
[illegible]	[illegible]	[illegible]	[illegible]
1891	[illegible]	[illegible]	[illegible]

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The production divided according to nature of fuel used in the furnaces was as follows, in net tons, spiegeleisen being included:

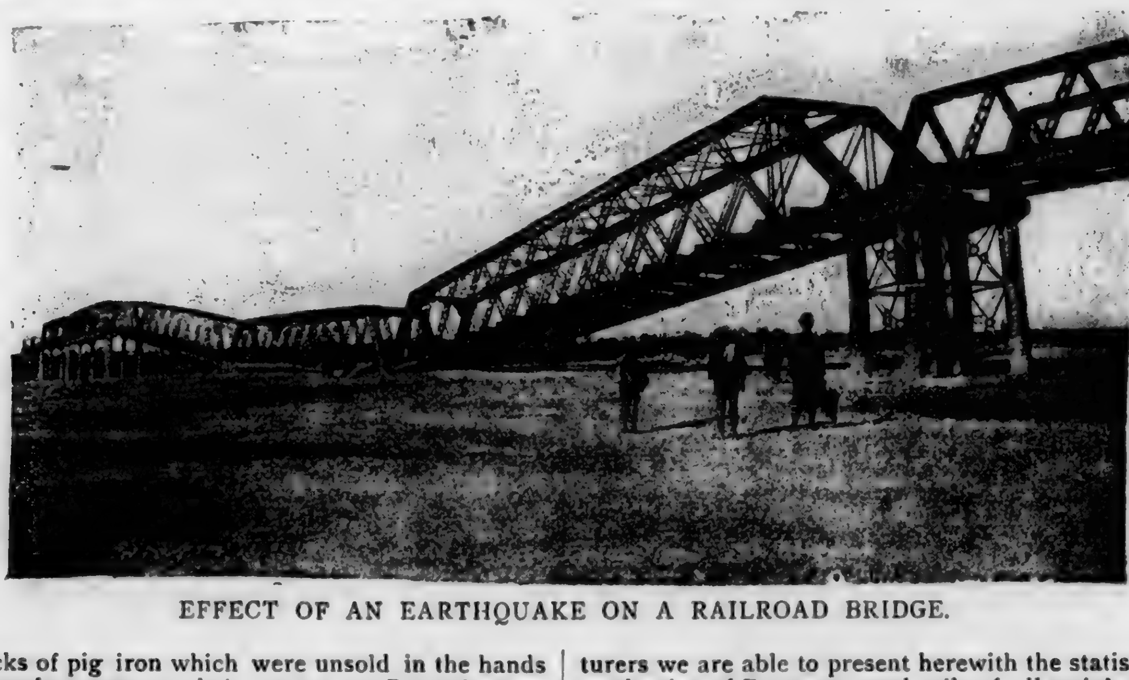
Fuel Used.	1891.	1890.
Charcoal	[illegible]	[illegible]
Anthracite Coal	[illegible]	[illegible]
Bituminous Coal and Coke	[illegible]	[illegible]
Total	[illegible]	10,307,028

The shrinkage in production in 1891 as compared with 1890 was distributed among the different fuels used in our blast furnaces, and it was shared by most of the pig-iron producing States in the North and West, most notably by Pennsylvania, which lost over half a million net tons, all

in the first half of the year. But the Southern States lost in the aggregate less than 40,000 net tons, while many of them actually increased their production in 1891 over 1890, as will be seen from the following table :

EFFECT OF AN EARTHQUAKE ON A RAILROAD BRIDGE.

States—Net Tons.	First Half 1891.	Second Half 1891.	Total 1891.	Total 1890.
Alabama	376,389	514,765	891,154	914,940
Tennessee	145,066	181,681	326,747	299,741
Virginia	141,908	188,819	330,727	327,912
West Virginia	20,977	75,660	96,637	144,970
Kentucky	18,779	31,446	50,225	53,604
Georgia	20,401	35,440	55,841	32,687
Maryland	49,992	88,214	138,206	165,559
Texas	8,465	12,437	20,902	10,865
North Carolina	1 003	2,600	3,603	3,181
Total	782,980	1,131,062	1,914,042	1,953,459



EFFECT OF AN EARTHQUAKE ON A RAILROAD BRIDGE.

The stocks of pig iron which were unsold in the hands of the manufacturers or their agents on December 31, 1891, and which were not intended to be used by the manufacturers, amounted to 596,333 gross tons, against 442,055 gross tons on June 30, 1891, and 608,921 gross tons on December 31, 1890. The above figures include a part of the stocks of pig iron held at the periods named in storage warrant yards, and which was under the control of the makers, the part not under their control on December 31 last amounting to 30,900 gross tons, which, added to the 596,333 tons above mentioned, makes a total of 627,233 gross tons which were on the market at that date. On December 31, 1890, the storage warrant yards held 52,900 gross tons of pig iron which were not under the control of the makers, making a total of 661,821 gross tons which were then on the market. The difference between the aggregate of unsold stocks at the close of 1890 and 1891 was only 34,588 gross tons.

If the demand for pig iron for consumption were now exceptionally active, and if prices were advancing, the stocks held at the close of 1891 would not be excessive. It is for the producers themselves to decide whether these conditions exist. It will be remembered that at the close of 1890 and soon afterward many furnaces were blown out because of the accumulation of unsold stocks, yet they did not then aggregate much more than the quantity with which we began the present year.

BESSEMER STEEL RAILS.

Through the courtesy of the Bessemer steel manufacturers we are able to present herewith the statistics of the production of Bessemer steel rails of all weights and sections in the United States in 1891, exclusive of the comparatively small quantity made by other manufacturers from purchased blooms. The total production in 1891 was 1,366,259 net tons, or 1,219,874 gross tons, a decrease of 577,615 gross tons from the production in 1890. The following table shows the production in each half of 1891 and the total production of the year compared with that of 1890, with the exception above noted for both years :

States.	First Half 1891. Net tons.	Second Half 1891. Net tons.	Total 1891. Net tons.	Total 1890. Net tons.
Pennsylvania	439,902	506,252	946,154	1,396,460
All other States	140,027	280,078	420,105	616,728
Total net tons	579,929	786,330	1,366,259	2,013,188

The production of Bessemer steel other than that worked up into rails has not yet been reported.

EARTHQUAKES VS. A BRIDGE.

In this country storm and flood make havoc sometimes with the bridge-builder's work, but the earthquake is not usually taken into account. What wreck those convulsions of nature may make is shown by the two cuts herewith, taken from the London *Engineer*. These are from photographs of the Nagaragawa railroad bridge in Japan, taken just after the terrible earthquake of October 28 last.

Of this bridge Professor Milne, of Tokyo, writes: "For vertically applied force the structure, from an engineering point of view, was all that could be desired; but in consequence of horizontally applied stresses the inertia of the upper part has resulted in fracture at the base, and an appalling destruction."

The whole line of the railroad, of which this bridge is a part, was very badly damaged, and its repair will take some time and a large expenditure of money.

Earthquake strains are not easy to calculate, and it will be a difficult task for bridge-builders in Japan to provide against such contingencies in the future.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 86.)

B. Screws to Lift and Propel.

In describing the various proposals and experiments which have been made to compass artificial flight by means of rotating screws, the latter will chiefly be considered as instruments from which to obtain support of a given weight in the air. There is no question that they can serve as propellers if the support be otherwise obtained; nor that if a screw can lift and sustain its own prime motor, it can also be made to progress horizontally, either by inclining it at the proper angle or by adding a vertical screw.

It was to be expected that when inventors found how difficult it is to obtain a lifting effect from flapping wings, they should turn to aerial screws to sustain them in the air. Man has succeeded in out-traveling both land and marine animals by substituting rotary motion for the reciprocating action of their limbs: the locomotive far outstrips the horse, and the paddle-wheel and screw have, for large vessels, superseded the oar, so that it seems natural to expect that some rotating device shall be found the preferable propeller, should aerial navigation ever be accomplished.

It will be seen, from the accounts which follow, that the chief obstacle has hitherto been the lack of a sufficiently light motor in proportion to its energy; but there has recently been such marked advance in this respect, that a partial success with screws is even now almost in sight.

Curiously enough, the Aerial Screw considerably antedates the marine screw, although, unlike the latter, it has not been brought into practical use. We have already seen that *Leonardo Da Vinci* experimented with paper screws, which mounted into the air, as early as A.D. 1500, and we may add that a sketch has been found in his note books for a proposed aerial screw machine 96 ft. in diameter to be built of iron and bamboo framework, covered with linen cloth thoroughly starched. He probably abandoned all idea of constructing it when his experiments with models showed the power that would be required.

A similar proposal was made by *Paucton*, a learned mathematician, in 1768, when, in a treatise upon the Archimedean screw, he described an apparatus which he called a "Pterophore," consisting of two aerial screws, one to sustain and the other to propel, attached to a light chair. A man seated in the chair was expected to rotate these screws by means of gearing, and so raise himself through the air.

The first practical experiment known, however, is that of M. *Launoy*, a naturalist, and M. *Bienvenu*, a mechanician, who jointly exhibited before the French Academy of Sciences in 1784 the little apparatus shown in fig. 25. It consisted of two superposed screws, about one foot in

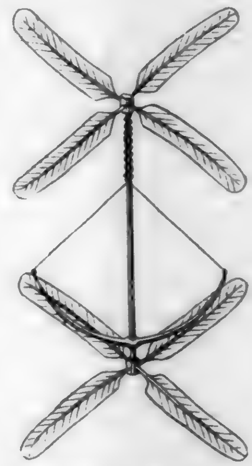


Fig. 25.—LAUNOY & BIENVENU—1784.

diameter, each composed of four feathers inserted in sockets at the ends of a rotating axle. This axle was put into motion by the unwinding of a cord fastened to the two extremities of a bow; and the report to the French Academy (May 1, 1784) says:

"The working of this machine is very simple. When the bow has been bent by winding the cord, and the axle placed in the desired direction of flight—say vertically, for instance—the machine is released. The unbending bow rotates rapidly, the upper wings one way and the lower wings the other way, these wings being arranged so that the horizontal percussions of the air neutralize each other, and the vertical percussions combine to raise the machine. It therefore rises and falls back afterward from its own weight."

Launoy & *Bienvenu* proposed also to build a large machine, and to go up in it themselves. It is not stated whether this was ever attempted; but probably not, as a brief investigation must have satisfied them that they had no adequate primary motive power at hand to lift even its own weight in that way, and that with a secondary or stored power the machine would fly but for a few seconds.

Practically the same device was constructed by Sir *George Cayley* in 1795, and described by him in *Nicholson's Journal* for April, 1810; but whether he reinvented it or borrowed the idea from *Launoy* & *Bienvenu* is not stated. He mentions it merely as a toy, and his writings seem to indicate that he expected success to be achieved instead with an aeroplane to be driven by some sort of propelling apparatus, if only a sufficiently light first mover could be contrived.

Subsequently, *Deghen*, in 1816, *Sarti*, in 1823, and *Dubochet*, in 1834, all proposed and constructed models for flying machines on the vertical screw principle; but they did not discover the necessary light motor to transform their models into practical machines.

In 1842 Mr. *Phillips*, the inventor of the "Fire Annihilator," succeeded in raising into the air an apparatus weighing in the aggregate 2 lbs., by means of revolving fans inclined about 20° from the horizontal. The motive power was evolved by the combustion of charcoal, nitre and gypsum making steam, as in the original fire annihilator; and the engine consisted of rotating arms discharging steam direct into the atmosphere, and thus working by reaction, being the device known as the discovery of Hero, of Alexandria. Mr. *Phillips* exhibited a work-

ing model of his aerial machine at the Aeronautical Exhibition in London, in 1868; and in describing his experiment of 1842 he said:

"All being arranged, the steam was up in a few seconds, when the whole apparatus spun around like a top and mounted into the air faster than any bird; to what height it ascended I had no means of ascertaining. The distance traveled was across two fields, where, after a long search, I found the machine minus the wings, which had been torn off from contact with the ground." This is undoubtedly the first machine which has risen into the air by steam power; but the necessarily small capacity of the generator, and the wasteful though simple method of using the steam, limited its flight to a very few minutes, and removed it from the possibility of application on a practical scale.

In 1843 Mr. *Bourne*, the well-known English engineer, constructed some models of aerial screws, consisting of large fowl's feathers inserted in a cork, stuck on the top of a pine stick, to which a watch spring was attached, and succeeded in making them rise by the force of the coiled spring to the height of some 20 ft.; but he recognized that the difficulty in the way of building a really navigable machine was to obtain "the right motive power."

This must also have been the conclusion of Mr. *Cossus*, who proposed, in 1845, the apparatus shown in fig. 26, which consists in three rotating aerial screws to be moved by steam power. The design is by no means devoid of

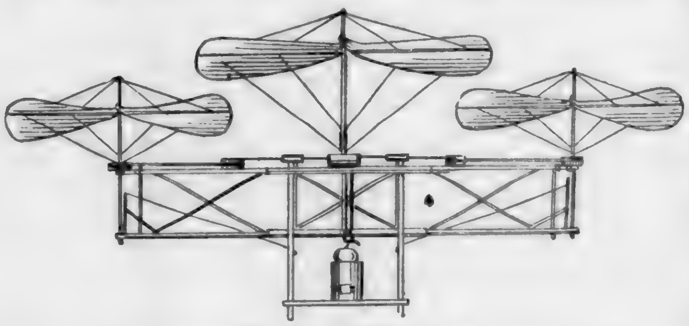


FIG. 26.—COSSUS—1845.

merit, for by hinging the outer and smaller screws, and varying their angle with respect to the machine, the latter can be made to travel in any direction desired, while sustained by the rotation of the middle screw. It cannot be learned that *Cossus* tried any practical experiments, for a simple inquiry into the weights and relative energy of the steam engines of his day and an investigation as to the power required to sustain his apparatus must have speedily convinced him that it had better be abandoned.

Analogous proposals were made in 1851 by Mr. *Aubaud*, who combined several screws with an aeroplane; and by *Le Bris*, who designed a car surmounted by two screws turning in opposite directions, in order to overcome the tendency of the apparatus to rotate on its own axis, as the consequence of the horizontal component of the thrust of a single screw.

It was to overcome this same objection that, in 1859, Mr. *Bright* designed and patented the apparatus shown in fig. 27, the axles of the screws consisting of tubes, rotating in opposite directions, one inside of the other. Mr. *Bright* seems to have planned the machine to be suspended beneath a balloon, and to be worked by man power, in order to alter or to maintain the altitude at will, and thus save the expenditure of ballast in rising or of gas in descending. Its beneficial effects, however, seem to have proved so small—solely, it may be said, from the inadequacy of the motive power employed—that it has not come into practical use.

These various efforts were somewhat desultory, and not followed up by anything like scientific experiments; but in 1863 there was in Paris a great "boom" in projects for navigating the air by means of aerial screws, and the French espoused its promotion with great enthusiasm. M. *de Ponton d'Amécourt* and M. *de la Landelle* had already studied the action of the screw upon the air, when, in July, 1863, M. *Nadar*, a prominent photographer, invited to his reception rooms the *élite* of the press, of science, and of artists, and treated them to a first reading of his famous "Manifesto upon Aerial Automotion," which appeared the next day in the press, and was republished and commented upon throughout the whole of Europe.

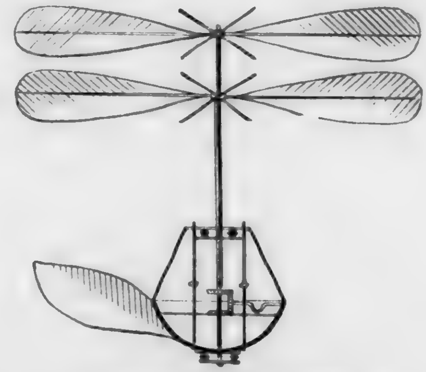


FIG. 27.—BRIGHT—1859.

In this manifesto, written with much eloquence, *Nadar* expressed the opinion that the principal obstruction in the way of navigating the air was the attention which had been given to balloons; that, in order to imitate nature, a flying machine must be made heavier than the air. Also that the surest means of success was the employment of the aerial screw—"the sainted screw," as an illustrious mathematician called it, which was known to be capable of carrying up a mouse, and must, therefore, *à fortiori*, be able to sustain an elephant.

The inanity of this argument was not apparent at the time; and *Nadar* proceeded to form a syndicate to promote "aviation" after the methods of opera bouffé. A journal was founded—the first *Aéronaute*—43 paying subscribers were obtained, and 100,000 copies of the first issue printed. This journal expired after its fifth issue. Then a monster balloon was built—the *Géant*—out of the exhibition of which it was expected to realize sufficient profits to build a screw machine which should put an end to ballooning forever. But the *Géant* met with all sorts of mishaps; it gave no profits, and entailed losses instead, which nearly ruined *Nadar;* and such experiments as were tried with aerial screws (outside of the little toys which were exhibited at the various meetings) demonstrated that the utmost weight which the exertion of one horse power could sustain, with a screw acting upon the air, was some 33 lbs., or, in other words, that if the apparatus were to weigh one ton, it would need 67 horse power continuously exerted to keep it afloat.

This is now clear enough to us. Assuming that in consequence of the rotation at high speed a smaller surface is required to sustain a given weight with a screw than with reciprocating wings or fixed aeroplanes, yet the motor for the screw would probably weigh about one-third of the whole weight of the apparatus (instead of one-quarter, as in the case of birds, and probably one-sixth in the case of aeroplanes), and so the utmost weight available for the motor of the screw and its supplies would be ⅓ of 33 lbs., or 11 lbs. to the horse power, while in 1863 there was no primary motor known then approximating such phenomenal lightness.

Now that Mr. *Maxim* has announced that he has built a steam engine, and its generator of 950 lbs. aggregate weight developing 120 actual horse power, or at the rate of 8 lbs. to the horse power, it is doubtless within his power to go up into the air with an aerial screw, and to perform therein various evolutions; but his trips would probably be short, and the consequences might be unpleasant were the machinery to break down while he is aloft. He has, accordingly, with great good judgment, begun by applying his steam engine to an aeroplane, although this will involve greater difficulties in starting and in landing, as well as a less immediate demonstration.

Almost the only memento which now remains of the movement in favor of the aerial screw inaugurated by *Nadar* is the model of the flying machine designed by the *Viscount de Ponton d' Amécourt*, and which is shown in fig. 28. The following description is translated from that of M. *Tissandier:*

"M. *de Ponton d'Amécourt* constructed, in 1865, an aerial screw machine worked by steam, which was expected to rise with both its motor and its steam generator. This beautiful little model, which was exhibited at the London Aeronautical Exposition in 1868, is exquisitely finished. The boiler and frames are of aluminium, and

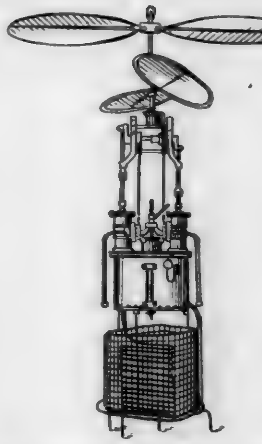


FIG. 28.—D'AMECOURT—1863.

the steam cylinders are of bronze. The reciprocating movement of the pistons is transmitted by gearing to a double pair of superposed screws of 41 sq. in. surface, one rotating in a different direction from the other. The apparatus, which is now in the collection of the French *Society for Aerial Navigation*, weighs, without water or fuel, 6.1 lbs. The boiler is 3¼ in. high and 4 in. in diameter; the total height is 24½ in. Unfortunately the boiler cannot be worked at sufficient pressure; when the machine is put into motion it possesses a certain ascensional force; it loses weight, but it does not rise."

The illustrated papers also published about 1865 views of a great steam flying machine, attributed to M. *de la Landelle*. These showed a hull flanked with aeroplanes, and surmounted with two masts, each carrying four sets of screws, and also a partly folded umbrella, presumably to open into a parachute. It is to be found reproduced in most works upon aerial navigation, and in encyclopædia articles, and is not given here, because it possesses no merit whatever, being probably a newspaper fancy, like the flying ship attributed to Mr. *Edison*, which went the rounds of the press some years ago, and which is also reproduced in M. *Dieuaide's* chart.

M. *de la Landelle* was a persevering man, as well as one of considerable scientific acquirements. He continued making experiments upon screws of various shapes long after MM. *Nadar* and *Ponton d'Amécourt* had given them up in disgust; and he encouraged M. *Pénaud*, then a ris-

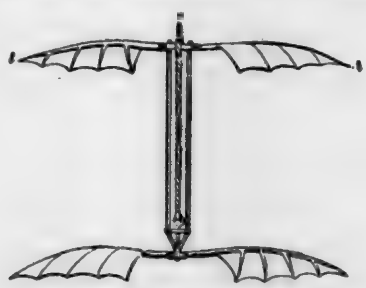


FIG. 29.—PÉNAUD—1870.

ing young man, to take up the study of aviation. The latter produced in 1870 the little apparatus shown in fig. 29, which has remained the best of its kind.

Pénaud's flying screw, which is called by the French a "Hélicoptère," consists of two superposed screws rotating in opposite directions, and actuated by the force of twisted rubber strings. The principle is the same as the apparatus of *Launoy & Bienvenu* and of Sir *George Cayley*, but the twisted rubber is far more effective than the bow, whether the latter be of whalebone or steel, and this change in the motor constituted the chief merit of *Pénaud's* modification. He first experimented with rubber in tension, but found that the increased weight of the frame (to resist the strains) more than compensated for the weaker effects of torsion, and that the latter application enabled him to construct models which were simple, cheap, efficacious, and not easily broken. These models, when built in varying proportions, would either rise like a dart to a height of some 50 ft., and then fall down, or sail obliquely in great circles, or, after rising some 20 or 25 ft., hover in the same spot for 15 or 20 seconds, and sometimes as many as 26 seconds, which was a much longer flight than had ever before been obtained with screws.

For lack of a sufficiently light primary motor, *Pénaud's* further experiments in this direction brought forth no practical results, and his apparatus has remained a toy, which has been varied in many ways.

The most popular of such toys have been the various single spinning screws, either of cardboard or metal, which are attached to a spindle around which a string is wound, and which are set in rapid rotation by briskly pulling and unwinding the cord. These are of many shapes, with two, three, or more arms, and of various angles of pitch. Those with heavy rims are most effective, sometimes rising as much as 200 ft. into the air; but they have led to accidents and proved dangerous. In such devices the source of power is not taken up into the air, as in *Pénaud's* apparatus, but it is stored in the momentum of the screw and encircling ring (if any) by the original muscular effort. Mr. *Wenham* measured the force expended in unwinding the coiled string by attaching thereto a small spring steelyard, and noting the time of ascent of a flying screw of tin plate with three equidistant vanes. He computed that to maintain the flight of the instrument, weighing 396 grains, a constant force is required of near 60 foot-pounds per minute, or in the ratio of about 3 horse power for every 100 pounds.

Many modifications have also been made of the double screw arrangement, which takes up its secondary motor in the shape of twisted rubber. These have been produced by many people; but the cleverest are probably those of M. *Dandrieux*, who, in November, 1879, presented before the French Aeronautical Society * no less than 10 different types, the best known of which is that of the butterfly, which is still to be found in the toy shops, and which comes to us both from Paris and from Japan. M. *Dandrieux* modified the shape and proportions of the screw, and effected a material improvement in its efficiency.

Flying screws driven by clock springs have been frequently made. Such an arrangement was constructed by Sir *George Cayley*, "the flying baronet," at the beginning of the century, and is described in his paper on "Aerial Navigation," in Vol. XV of *Nicholson's Journal*. Sometimes the attempt has been made to substitute man power. Of such was the experiment of Mr. *Mayer*, a stair-builder, who, about 1828, constructed an aerial screw proportioned to sustain 126 lbs., and rotated it with his own muscular power. In giving an account of the result, forty years later, he said, naively: †

"The result was very flattering, though not perfectly successful. My pecuniary resources were exhausted, and other work in my own business being then offered to me, ascending by wings (screws) was abandoned until a more convenient season, and the more certain and substantial method of making stairs, and ascending them step by step, was substituted in its place."

(TO BE CONTINUED.)

Recent Patents.

BEAUDRY'S POWER-HAMMER.

THE accompanying illustrations show an improvement in power-hammers covered by patent No. 461,917, recently issued to Alexander Beaudry, of Boston. In the drawings fig. 1 is a sectional front elevation of a hammer embodying the improvements, the right side of the figure representing

* *L'Aéronaute*, January, 1880.

† Third Annual Report Aeronautical Society of Great Britain.

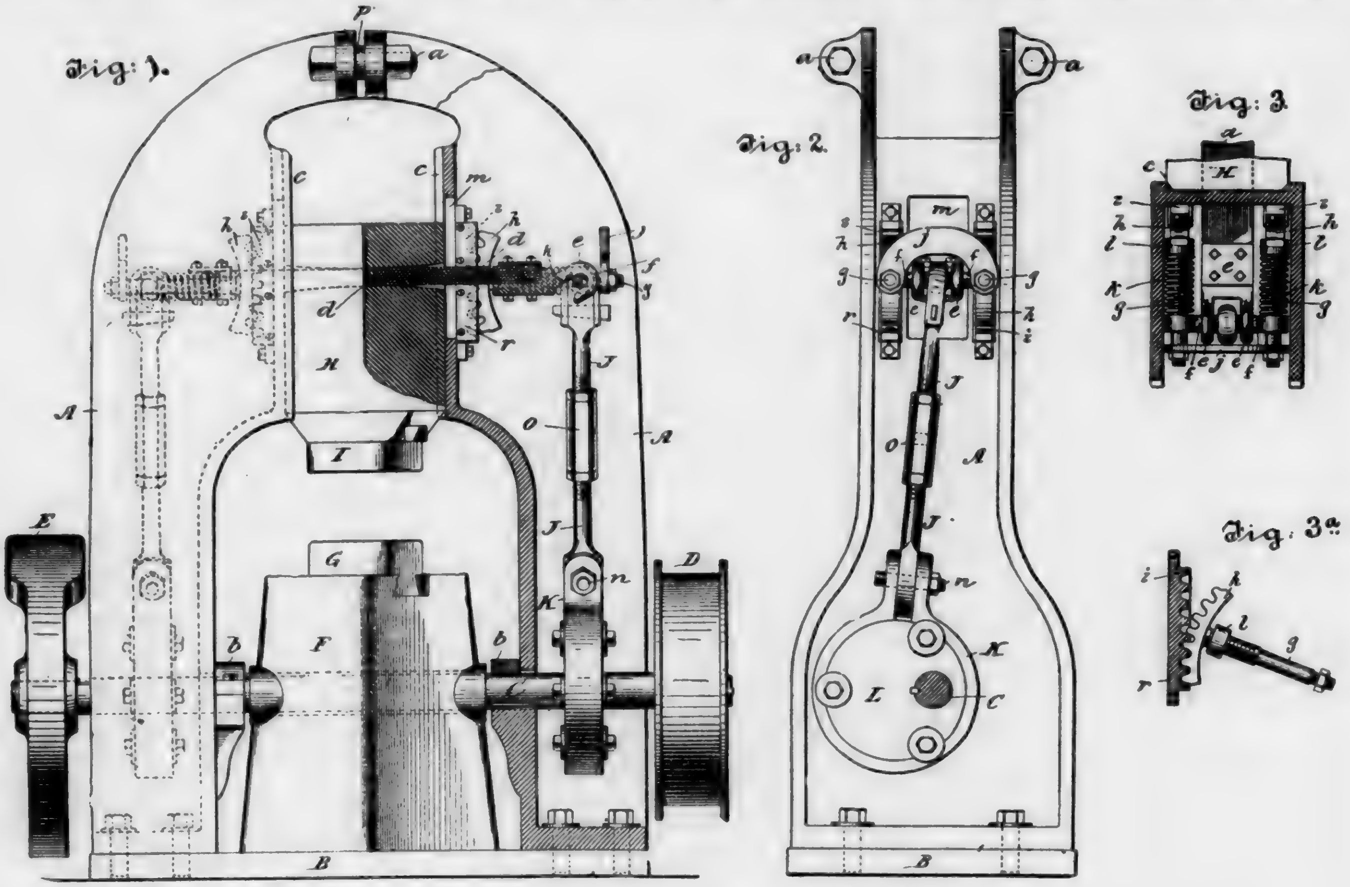
parts of the hammer in section and a part of the frame broken away. Fig. 2 is a side elevation with the fly-wheel removed and the main shaft in section. Fig. 3 is a sectional plan, the plane of the section being indicated by the line 3 3 in figs. 1 and 2. Fig. 3*a* is a detail view, which will be hereinafter described.

A represents the frame of the hammer, which is preferably constructed of two like sections or halves of cast iron, which are united at their tops by bolts *a* and secured at their bases to a bed-plate *B* by bolts. *C* is the main or driving shaft mounted in bearings *b* in the frame *A*. On one end of this shaft is the driving-pulley *D* and on the other end is the fly-wheel *E*. This shaft passes through an opening formed in the anvil-bed *F*, which is mounted on the base *B*. In this bed is set the anvil or lower die *G*.

Mounted in vertical guideways or keepers *c*, formed in the inner faces of the two sections of the frame *A*, is the hammer-head *H*, which carries the removable die or former *I*. The head *H* is inserted in its guides from the top of the frame *A*, which is left open to permit it to enter freely, and said head is adapted to play up and down in its guideways *c*.

To give a vertical reciprocating movement to the hammer-head, this head *H* is suspended on a stout strap *d*, preferably composed of several strips of rawhide superposed. This strap is passed through an eye in the head, and has hooks *e* secured to its respective ends. Each hook engages a yoke or cross-head *f*, to which is coupled a connecting-rod *J*, said rod being coupled at its lower end to the strap *K* of an eccentric *L*, fixed on the shaft *C*. This mechanism on one side is an exact duplicate of that on the other side. In fig. 1, one side of the frame is shown broken away, leaving this mechanism in full view. The cross-head *f* has eyes in its ends and is slipped upon the stems *g* of two similar curved racks *h h*, which gear with two straight racks *i i*, secured to the outer face of the frame *A*. The stems of the two curved racks are connected by a tie *j*, and on said stems are cushion-springs *k*, which abut at their inner ends against collars *l l*, fig. 3. The cross-head *f* bears on or against the outer ends of said springs.

In fig. 3*a* a curved rack *h* and a straight rack *i* are seen detached, the latter being shown in section. It will be seen that the cushion-springs *k* on opposite sides of the frame *A*, which will be under considerable tension, tend to strain the strap *d* taut, and thus enable it to support the hammer-head without sagging. When the shaft *C* is set in motion, the eccentrics *L*, acting through the connecting-rods, *J*, impart a vertical reciprocating motion to the cross-heads *f*, and these latter, moving up and down in unison, impart an up-and-down motion to the hammer-head *H* through the medium of the strap *d*. In its vertical movement the strap *d* plays in apertures *m* in the frame *A*. As the cross-heads *f* move up and down, the curved racks *h* rock on the straight racks *i*, and thus cause the cross-heads *f* to move in substantially parallel planes. This prevents any appreciable slacking of the endwise strain on the strap *d*. However, as in this class of hammers the normal movement of



BEAUDRY'S IMPROVED POWER-HAMMER.

travel of the hammer-head (due to the throw of the eccentrics in this case) is exceeded when the hammer-head is in rapid movement, owing to the acquired momentum of said head, the strap will be flexed at the end of the downstroke (and to a less extent at the end of the upstroke) and the cross-heads *f* will be drawn inward, the springs *k* yielding to allow for this flexure. This inward movement of the cross-heads *f* will draw the connecting-rods *J* inward at their upper ends to a slight extent, and to allow for this these rods are coupled to their respective eccentric-straps by coupling pins or bolts *n*, the axes of which are at right angles to the axis of the eccentric-shaft *C*. In order to allow for the swinging movement of the connecting-rod forward and back as the eccentric rotates, the bearing on this cross-head *f* where it receives the upper end of the rod is made of a spherical form. The connecting-rods may be provided with coupling-sleeves *o*, whereby they can be lengthened and shortened within limits for accurate adjustment of their length.

When the guideways in the frame and the sides of the hammer-head shall have become worn to such an extent that the latter plays too loosely, the two sections of frame *A* may be brought nearer together by inserting a thinner washer *p* at their upper ends and screwing up the bolts *a* thereat, and the bolts which secure the bases of the frame-sections to the bed-plate *B* may be loosened and the said sections set nearer together at the base. The bolt-holes in the frame will be slotted for this purpose. In order to keep the curved racks *h* in engagement with the straight racks *i*, or to insure against the former slipping laterally off the latter, the racks *i* are provided with side plates *r*, as shown.

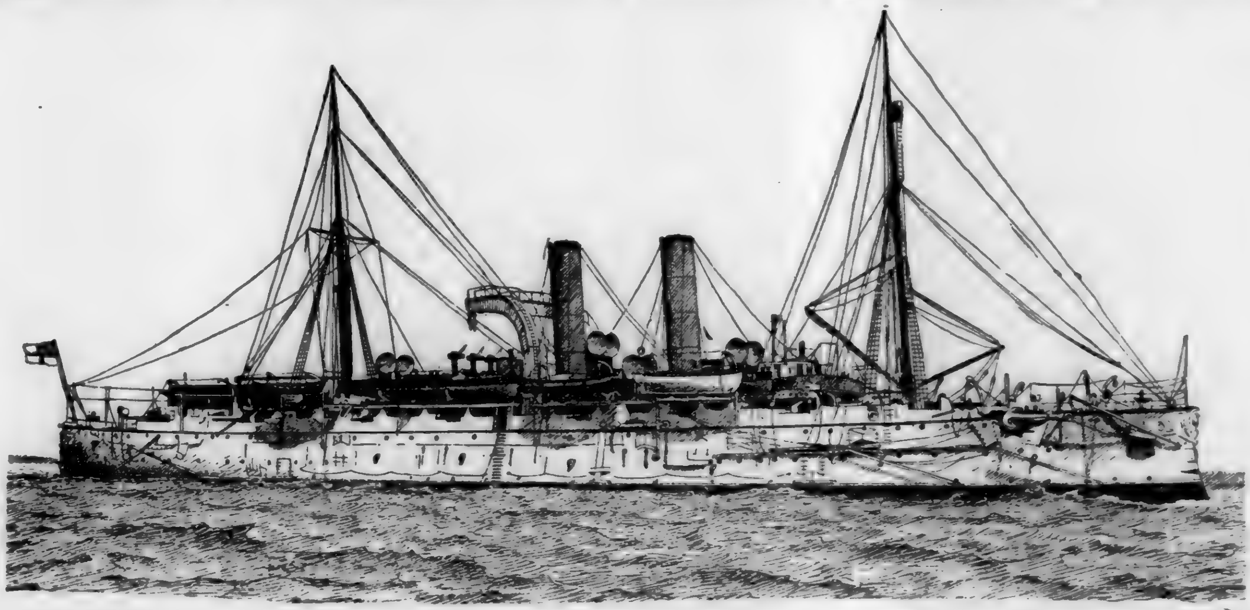
The curved racks *h* and straight racks *i* are used as a means of preserving the parallelism of the cross-heads *f* in their reciprocating movements; but other means or parallel mechanisms may be employed for this purpose.

Foreign Naval Notes.

AN ENGLISH TORPEDO TENDER.

THE accompanying illustration, from *Le Yacht*, shows the English torpedo-tender *Vulcan*, a ship which has caused much discussion.

The *Vulcan* was launched in 1889, and the chief dimensions are: Length, 348 ft.; breadth, 58 ft.; mean draft, 22 ft.; displacement, 6,620 tons. She has twin screws, each driven by a triple-expansion engine of the ordinary type. On the trial trips these engines worked up to 8,166 H.P. with natural and 12,000 H.P. with forced draft, and gave the ship an extreme speed of 18.5 knots.



TORPEDO TENDER "VULCAN," BRITISH NAVY.

The *Vulcan* carries on deck six small torpedo-boats which can be quickly put in the water by means of large hydraulic cranes, which are shown in the engraving back of the smoke-stacks. Her chief purpose, however, is to act as tender to a torpedo fleet, and for this object she can carry a large amount of stores, and has between decks a completely fitted up machine-shop, where repairs of almost all kinds can be made. Her armament consists of 20 small rapid-fire guns arranged to repel attack from torpedo-boats, and she has no heavy guns.

On the first trials the *Vulcan* did fairly well, but since then there has been much trouble with her engines and boilers; it is also claimed by some of the critics that she has shown structural weakness, which would seriously interfere with her usefulness as a floating workshop at sea.

THE FRENCH CRUISER "JEAN BART."

The accompanying cut, reproduced from *l'Illustration*, shows the new first-class cruiser *Jean Bart*, which has just been completed for the French Navy. This ship has received her armament, and is now undergoing her final trials.

The plans for this cruiser were the work of Chief Engineer Thibaudier. As originally drawn the ship was to carry a considerable sail area, but this has been changed, and she has only two military masts, or rather towers, for the masts are really towers, and each carries three tops, two of them being of very large size. The French naval authorities seem to favor these large tops and heavy masts.

FIRST-CLASS CRUISER "JEAN BART," FOR THE FRENCH NAVY.

The *Jean Bart* is 353.25 ft. long over all; 43.62 ft. beam; 30.50 ft. in depth; 20.14 ft. draft aft, with normal load; 4,162 tons displacement. Measuring by displacement, she is about the size of the *San Francisco* or the *Newark* of our own Navy, and is of a very similar class.

The armament includes four 16-cm. (6.3-in.) breech-loading rifles; six 14-cm. (5.5-in.) breech-loading rifles; six 47-mm.

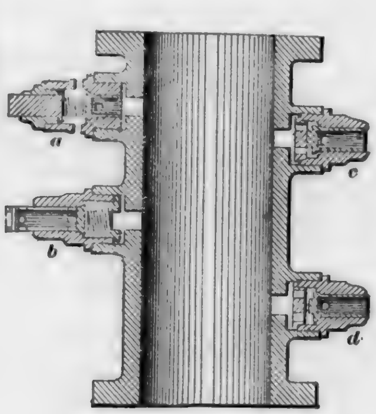
(1.85-in.) and two 65-mm. (2.56 in.) rapid-fire guns; eight revolving cannon; four torpedo-tubes. It is not very heavy for a ship of her size.

Manufactures.

A New Power-Hammer.

THE accompanying illustrations show a new power-hammer of the pneumatic type; it is driven by a belt, but air is the medium by which motion is transmitted to the hammer-head. Fig. 1 is a perspective view of one of these hammers; fig. 2 is last named being merely admission valves, which admit air to supply the place of what may be lost in case there is any leakage. This they do automatically and at each stroke, so that any reasonable amount of leakage does not interfere with the working of the hammer, and the piston and stuffing-box need not be so tight as to interfere with free working. The valves at the back of the cylinder *a* and *b* are those by which the motion of the hammer is controlled; they are opened and closed by means of a sliding wedge, which is connected to the system of levers before referred to, and clearly shown in fig. 2. These valves open in reverse directions, so that when one of them is opened by the wedge the other is closed. Valve *a* being closed, or the tension upon the spring which tends to close it being increased by the action of the wedge, the air is confined above

Fig. 3.



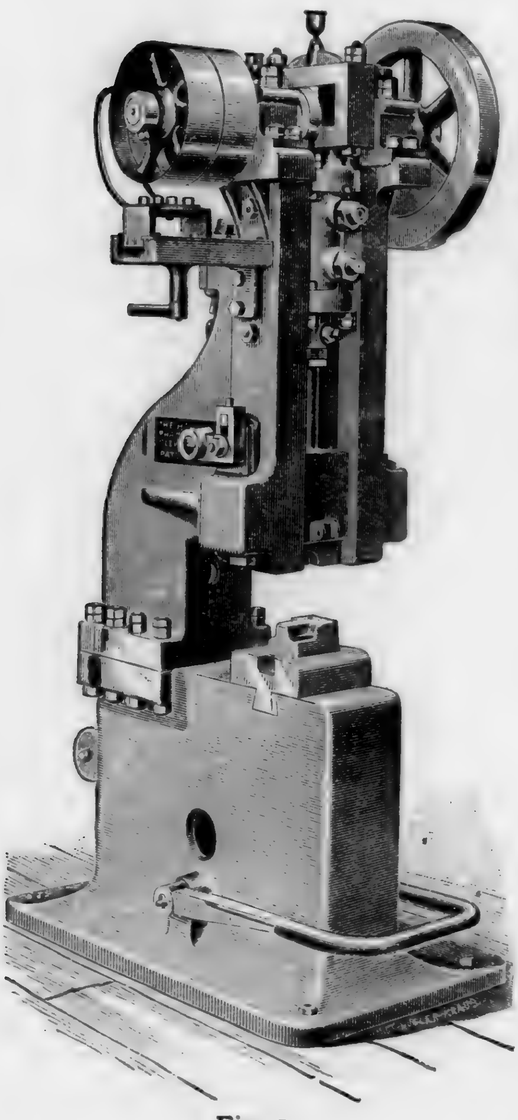


Fig. 1.

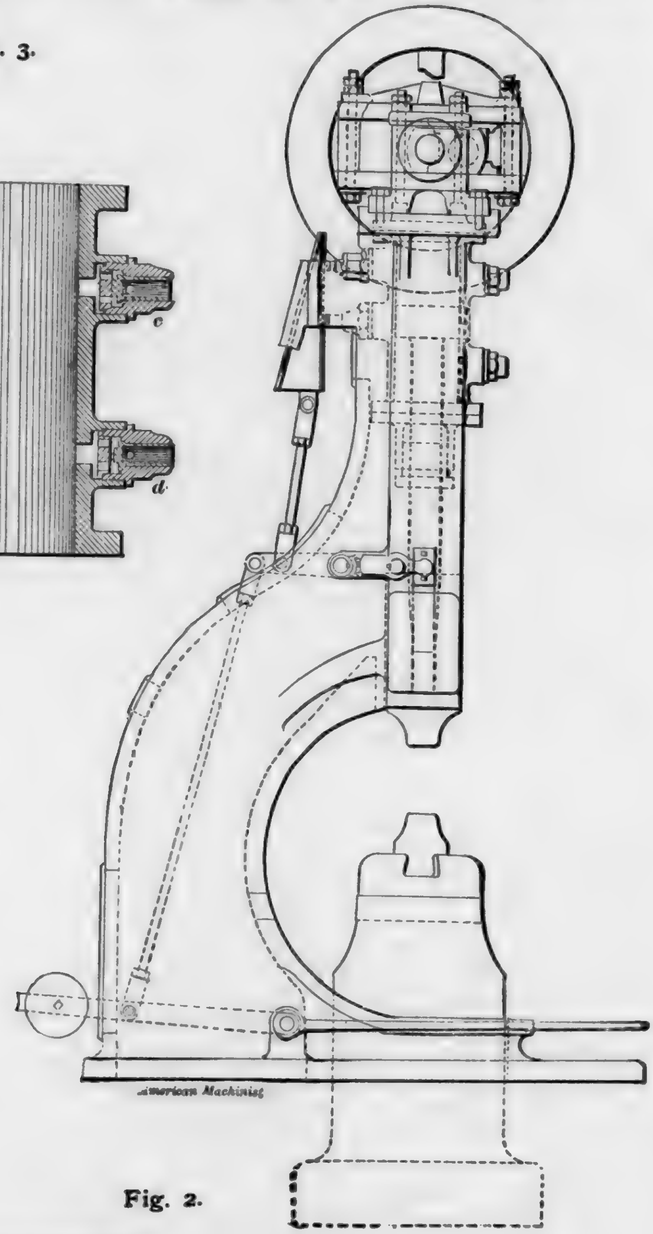


Fig. 2.

THE HACKNEY POWER-HAMMER.

a side elevation showing the construction, and fig. 3 is a section of the cylinder on a larger scale.

At the top of the standards there is a forged-steel crank-shaft working in bearings of phosphor-bronze, one on each side of the crank. The crank works in a yoke, having a sliding box of phosphor-bronze, this yoke being attached directly to the air cylinder below, which is thus given a vertical reciprocating motion in the slides formed in the standards. Within this cylinder is a piston, which, by the usual rod, is attached to the hammer-head, the air, more or less of which is confined above and below the piston, serving to transmit motion to it and to cushion it at the end of each stroke.

The admission and confinement of air in the cylinder is controlled by valves, which may be worked by hand or foot, as is most convenient, these valves, and the method of controlling them, being shown in figs. 2 and 3. In the larger sizes of hammers there are four valves, as shown at *a*, *b*, *c*, and *d*, the two the piston, which is thereby forced down, valve *b* being at the same time opened, so that, until the piston has passed this valve, its motion is unimpeded. After passing the valve *b* the air confined below this point cannot escape and is compressed, forming a cushion, and helping to raise the piston after the blow has been delivered.

It will be understood that the action of the air, its compression, etc., depends upon the relative motions of the piston and cylinder as much as upon the absolute motion of either, while the intensity of the compression, and consequently the force of the blow delivered, depends upon the degree of opening of the valves *a* and *b*.

The motion of the hammer is considerably greater than that of the cylinder, and the action of the valves is so prompt and certain that a single blow can be delivered with the maximum force, and the hammer will be arrested and held at the upper end of the stroke by a brake provided for that purpose, which

is controlled by the same lever that operates the valves. This enables the hammer to be used for drop-forging simply by putting in suitable dies for that purpose, and without any other special preparation whatever.

The guides for the cylinder and hammer-head are adjustable for wear, and can easily be replaced. In the smaller sizes the lower part of the hammer, upon which the die block rests, is made separately, so that it may be easily renewed in case of breakage.

The hammer shown is of the 50-lbs. size; it weighs 2,500 lbs.; is 6 ft. 2 in. high over all; has 7 in. travel of head; uses dies $5\frac{1}{2}$ in. long; is driven by a $3\frac{1}{2}$-in. belt running on a 10-in. pulley, and can be run up to 380 blows per minute.

The larger sizes—300 lbs. and over—are made with a double standard and separate anvil-block, the arrangement of cylinder and valves being the same as those shown. The largest size made—500-lbs.—weighs 14,000 lbs.; is 8 ft. 5 in. high; has 14 in. travel of head; uses dies 14 in. long; is driven by a 5-in. belt over a 24-in. pulley, and can be run up to 200 or 250 strokes per minute.

These hammers appear to be very substantial and serviceable tools. They are made by the Hackney Hammer Company, of Cleveland, O.

A New Milling Machine.

THE illustration given herewith shows a No. 4 plain milling machine made by the Brown & Sharpe Manufacturing Company in Providence, R. I. This is a new machine, lately added to that company's list.

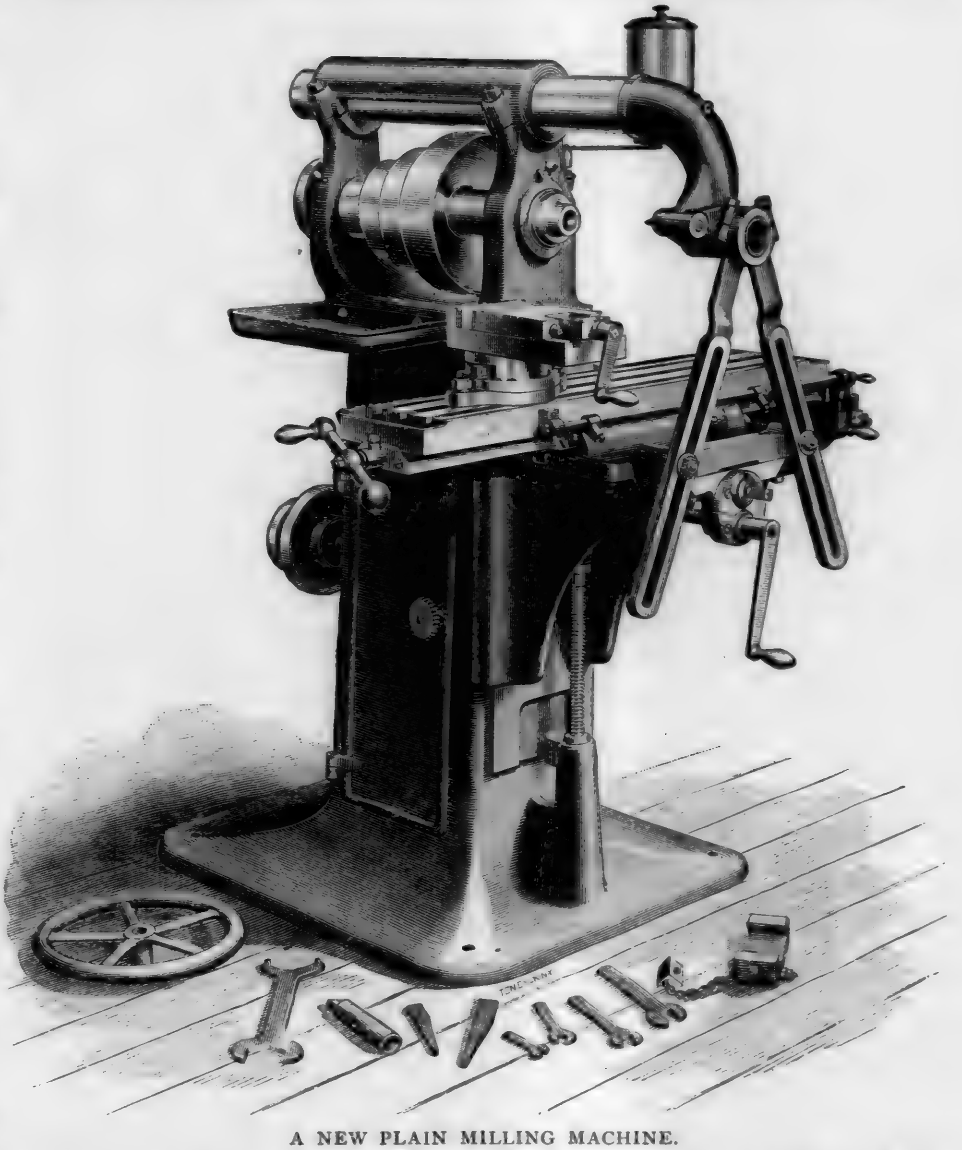
The overhanging arm supports the outer end of the cutter arbor, either on a center or in a bushing, and may be rigidly connected with the knee by an arm brace. The spindle-boxes are of bronze. The saddle rests directly upon the knee; the platen is heavy and moves only at right angles with the spindle. It has three T-slots and is surrounded by a channel for oil.

The platen is 32 in. long and 7 in. wide; it has an automatic feed of 20 in., and may be stopped automatically at any point while moving in either direction. It can be lowered $18\frac{1}{2}$ in. from the center of the spindle, and the saddle has a movement of $6\frac{3}{4}$ in. in line with the spindle. The greatest distance from the center of the platen to the face of the stand or knee-slide is 11 in. There are six changes of feed varying from 0.008 in. to 0.100 in. per revolution of the spindle.

The vise swivels and has a graduated base; the jaws are $5\frac{1}{2}$ in wide, $1\frac{1}{2}$ in. deep, and will open $2\frac{3}{4}$ in.

The various tools, wrenches, etc., furnished with the machine are shown in the engraving. The overhead works have two friction pulleys 14 in. in diameter for $3\frac{1}{2}$-in. belt, and hangers with adjustable and self-oiling boxes. The counter-shaft should run about 110 revolutions per minute.

This machine weighs about 1,800 lbs., and occupies a floor-space of $64\frac{1}{2} \times 44$ in. Its general design is well shown in the engraving.



A NEW PLAIN MILLING MACHINE.

Paint for Machinery.

MOST manufacturers and foremen know how difficult it is to find a paint which will stand on iron work and machinery, and which will not be affected by grease, oils, water, steam or heat. It is claimed by the makers of the Lawrence steel-color paint that it possesses the qualifications required, and is especially suited for use on pumps, radiators, boiler fronts and machinery subject to changes of temperature. It is easily applied and dries almost immediately, and is also well adapted for use as a foundation for other paint on surfaces.

Meyer's Automatic Cut-off Engine.

THE accompanying illustrations show an engine with the patent valve-gear and cut-off devised by Mr. H. H. Meyer and built by the Davenport Foundry & Machine Company, of which he is General Manager. Fig. 1 is a plan and fig. 2 an elevation of the valve motion; fig. 3 is a general view of the engine.

The valve motion, which is the distinguishing feature of the engine, is a modification of the link motion devised by Baron Heusinger von Waldegg for locomotives. In this engine the cross-head connection of the von Waldegg valve-gear is not used, but the same motion is obtained by using a compound rocker.

The drawings, figs. 1 and 2, show the gear of an 8×12-in. engine. The piston is supposed to be at the back end of the cylinder, and the valve just in position to admit steam, while the exhaust is full open. It is claimed that this gear moves the valves with such rapidity at the proper moment that steam is admitted into the cylinder at absolute boiler pressure; this result is attained by the eccentric being in the center of its travel when the piston is at either end of the stroke and just when the valve is at the point of opening the steam-port.

The valve derives its rapid motion from a stationary link, whose arm, at a right angle, is connected to a single eccentric; a block in the link connected to the governor varies the cut-off from three-fourths stroke to zero, without varying the lead—giving a perfect regulation of speed to the engine. The movement of the link is very short, and it is so constructed that any wear of the block can easily be taken up.

The long-stroke engines are made with two admission and two exhaust valves, also of the piston type, and each valve opens two passages for the admission and release of steam. This arrangement of valves, together with the positive motion they

receive from the link, is claimed to be superior to any other valve motion.

The valves are of the piston type, made as light as possible and fitted with spring rings which travel in removable seats, either of which can be replaced when worn in a very short time and at a trifling expense, without taking the cylinder from the frame.

The governor is designed to run from 1½ to 3 times faster than

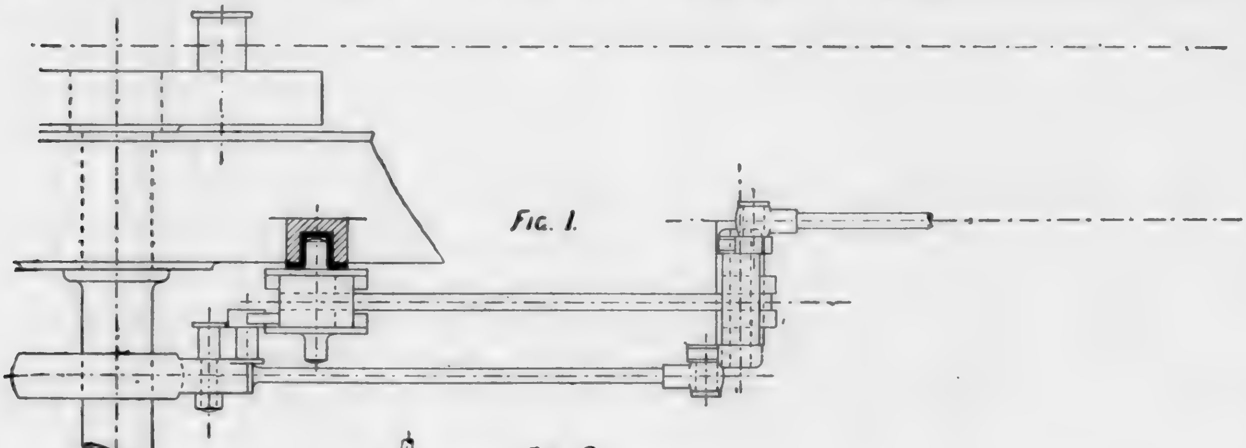


Fig. 1.

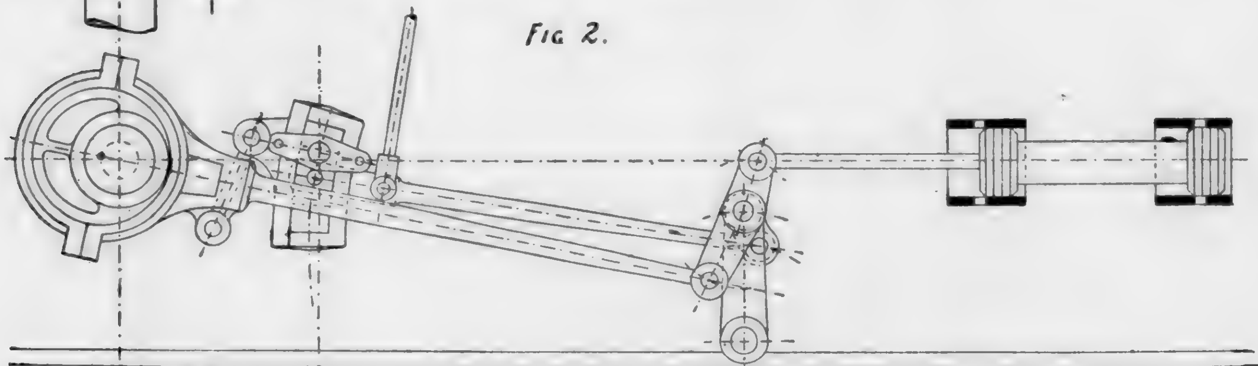
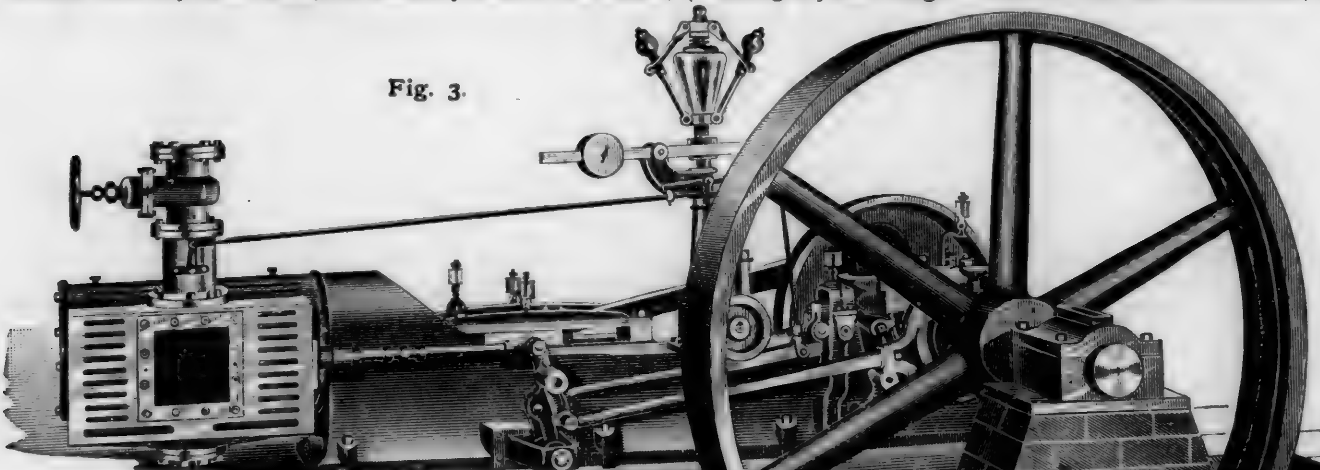


Fig. 2.

the engine itself; the balls being very small and pivoted so that they will fly out in nearly a straight line, it is therefore very sensitive and powerful. It has a safety device attached, which in case the belt should break or the governor should fail to work from any other cause, will instantly shut off the steam;

Fig. 3.



MEYER'S AUTOMATIC CUT-OFF ENGINE.

the speed of the engine can be varied while in motion by moving the counterpoise on the arm that takes hold of the link-rod; the speed is first regulated by more or less compressing the spring which is placed between the sliding ring and a nut on the governor stem.

By connecting the link-block to a screw with a small hand-wheel the cut-off is made variable by hand; by connecting the link-rod to a hand lever the engine can be made reversible. The motion is well adapted for a low-speed engine, as well as to a quick-running one.

An engine of this type, with 24 × 36-in. cylinder, which has been in use in Davenport two years, running at 110 revolutions, will not vary more than 1½ revolutions per minute between a full load and no load at all.

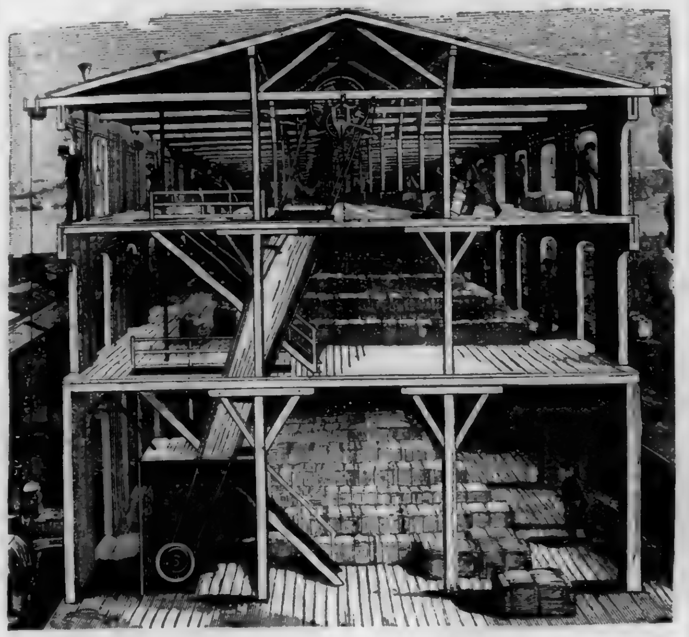
The bed-plate of this engine is of the Porter type, but made wider between the main bearing and guides. The crank is a disk, properly counterbalanced. The connecting-rod, which is three times the length of stroke, is fitted with Meyer's interlocking key and wedge. The valve and link connections, crank and cross-head pins are all of steel, hardened and ground to a fit.

The advantages claimed for this type of engine are simplicity; wide range of cut-off; close regulation, and high power resulting from quick admission giving full pressure in the cylinder.

Hoisting Machinery.

THE cut on this page is a sectional view of the hay depot of the New York Central & Hudson River Railroad at Thirty-third Street, New York, which contains a remarkable and extensive arrangement of hoisting machinery. It was necessary in this case to provide a large number of hoists which could be easily and quickly started and stopped, and could be run from a central line of shafting. The pattern finally adopted was that made by the firm of Volney W. Mason & Company, of Providence, R. I.

In the building there are 61 of these hoisting machines, driven by a main line shaft having its bearings in the top of



HAY DEPOT AT THIRTIETH STREET, NEW YORK.

each machine, there being fast on the shaft over each machine a paper friction wheel, while the hoisting machine below carries a winding drum, with a larger friction wheel on its side, which is caused to engage with the paper friction wheel over it by means of a double eccentric, or two cam bearings, one each side of the machine frame, connected by one lever. Pulling upward on the lever causes the drum and wheel to come into contact by a parallel movement toward the running wheel, friction contact causing the drum to wind up the hoisting wire

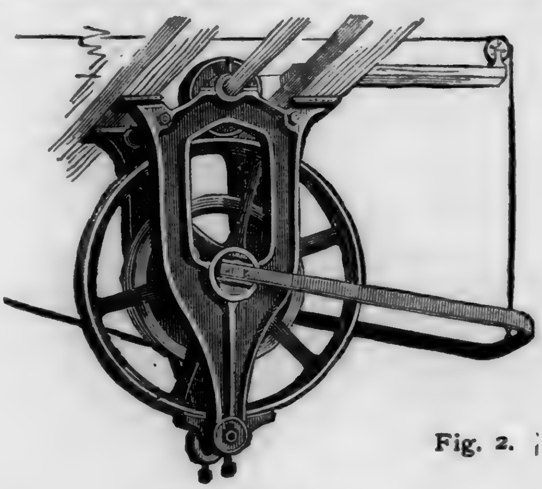


Fig. 2.

THE MASON HOIST.

rope as far as desired. On releasing the lever it falls back, and the wheel drops on a leather brake-shoe on the other side, holding the load stationary, the lowering away being accomplished by lifting the lever off the brake between the brake and driving-wheel; lowering away, hoisting or holding the load being controlled, as required, by the movement of the lever, the load being always held at rest by the brake upon letting go the controlling lever.

One of the hoists is shown in detail in the smaller cut, fig. 2.

In practice the hay brought in on the road is hoisted from the cars or platform, on the north side of the building, into the several stories, as desired, and delivered to the dealers' teams on the south side of the building.

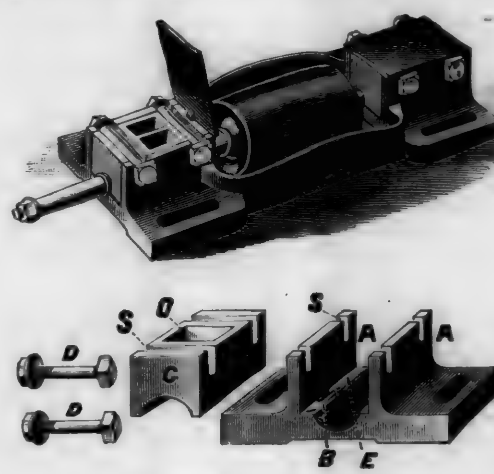
The arrangement of the shafting presents an interesting feature, there being seven level lines, each 80 ft. long, and each line 1 ft. lower than the other from Eleventh Avenue toward the Hudson River, the lines each being connected by a pair of universal couplings and a piece of shaft 6 ft. long, on an incline or angle dropping 1 ft. in 6 ft. The power is furnished by two Westinghouse engines of 25 H.P. each, running at a speed of 390 revolutions per minute, the driving belts running to two friction pulleys 54 in. diameter and 8 in. face each, on the main shaft in the top story. By using these pulleys, which are a new style of balanced segment friction pulleys, designed by Mason & Company, either of the engines may be thrown on or off instantly, when running at speed or stopped, so that either engine can be used separately, or both together, to drive the main shafting, as required. This pulley, it may be noted, was especially designed for running continuously on main line shafting, for driving electric light and other machinery started and stopped from the main shafting, and many pulleys made after this pattern have been put in operation.

This hoisting machinery has been in operation for some time, and its service has been entirely satisfactory.

A New Journal-Box.

THE accompanying illustration shows a new form of journal-box, patented by J. J. White and made by the Pennsylvania Machine Company, limited, in Philadelphia. It is designed especially for high-speed machinery. The Franklin Institute recently awarded the Longstreth medal for this invention.

Briefly stated, the improvements consist in making the walls *A A* of the casting to extend up to the height of the top of the cap-box *C*. These walls being planed through longitudinally, the cap is neatly fitted between them. To secure the upper or cap-box, instead of using bolts or screws to draw it down in the



A NEW JOURNAL-BOX.

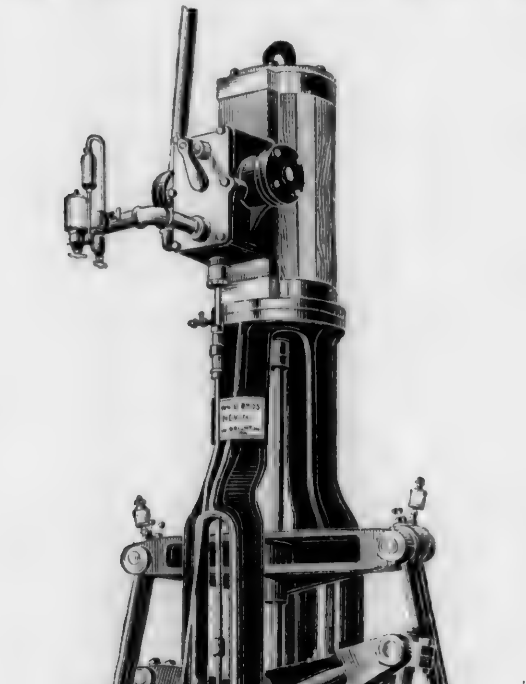
direction of the shaft it is clamped in position by bolts *D D*, laid in grooves *S*, cut transversely to the axis of the shaft across the top of the cap and through the side walls. By tightening these bolts the walls are drawn together, clamping the cap-box firmly between them. A large oil chamber, *D*, is provided in the upper cap. The packing of paper or wood usually found in the ordinary journal-box is entirely dispensed with here, thus leaving room for a strip of wicking *E*, one edge of which comes in contact with the shaft for lubrication, and the other edge connects with an oil well, *B*. Channels are provided in the casting for carrying any excess of oil back to the well.

It is claimed that this journal-box can be adjusted to the shaft much more quickly and accurately than one of the usual type. This is accomplished by thoroughly oiling the shaft where it enters the box, and placing the cap in position where it seats itself upon the oil in accurate adjustment; then by tightening the bolts immediately the cap will be rigidly secured in its proper place. No amount of strain that can be put upon the bolts can effect the adjustment of the cap, which is evenly separated from the shaft by the film of oil. Experience has shown that the clamping of a journal-box in this way is effective and durable. This fact will be apparent when it is considered that split pulleys are clamped to shafting, and that, notwithstanding the leverage of the pulley, they hold satisfactorily.

A Steam Pump for Artesian Wells.

THE accompanying cut shows a direct double acting steam pump devised for the purpose of pumping water from artesian wells, where a large quantity of water has to be raised. The illustration is a prospective view, and shows the pump with an air-chamber attacned, which is omitted when not required.

The pump-head or engine consists of a strong iron frame which carries a pair of oscillating levers on steel bearings.



THE DOWNIE DIRECT-ACTING STEAM PUMP.

The sucker rods are balanced by this means, so that their weight rests upon the bearings and not upon the piston, as in single-acting pumps. The steam cylinder is mounted upon top of the frame as shown, the whole resembling a compact upright engine. The valve is operated by an auxiliary piston and valve of simple construction; the throw of this valve regulates the length of stroke of the pump, and it is driven by a cam movement, also shown in the engraving, which can be readily and quickly adjusted. The pumps are made in various sizes, the steam cylinders having a clear stroke of 24 in., and varying from 5 in. to 9 in. in diameter.

These pumps are made in a careful manner; the piston rods are of steel, and the pistons have metallic expansion packing rings; the stuffing-boxes and glands are of brass. Each is fitted with a sight-feed lubricator and all necessary oil-cups and other fittings.

The advantages claimed for this form of pump are the increased amount of water raised; the constant stream of water thrown; the greater amount of work done with the same sized cylinder; the greater steadiness of working and the entire absence of the loss of the power required to start the column of water in a single-acting pump. It is also an advantage that the sucker rods are used to counterbalance each other's weight, relieving the piston and piston rod entirely. The actual capacity is much greater than a single-acting pump having the same size of steam cylinder.

These pumps seem to be very well designed and adapted for their purpose. They are neat in design and compact in form, taking up very little room.

It may be added that the base-plate is made detachable, so that the pump-head can be easily removed when it is necessary to take out the sucker rods and valves for any purpose.

These pumps have been in use for some time, with excellent results. They seem especially well adapted for railroad water stations where the supply is from wells. They are made by Downie Brothers & Nevin, Limited, in their shops at New Brighton, Pa., and the essential points of their design are covered by patents.

Self-Contained Machines.

HOWEVER well designed a manufacturing establishment may be, changes are almost constantly going on as more recent improvements are incorporated with the original plant.

Considering this certainty, much more valuable and satisfactory is the self-contained machine, which may be readily shifted from place to place and do its work as well when located but temporarily as when all the precautions are observed for an indefinite operation.

A striking instance of this was lately noted at the works of the Laurel Hill Chemical Company, at Laurel Hill, N. Y. Two timbers laid upon the ground, and braces by strut pieces from the ceiling, form the bed of the outfit, which consists of a 25 H.P. Westinghouse engine driving a salt-cake crusher and grinder.

Each machine is complete in itself and independent of its surroundings, and the engine easily runs with perfect safety at a speed of 400 revolutions per minute on its slender foundation.

It may be interesting to note in this connection the extremes of speed in the power and its application.

While the plant is not intended as a permanent one, the character of the production is no different from what could be obtained under more favorable conditions, and each machine yields, as a whole, to the inequalities of the foundation with no undue tendency to strain or warp the working parts.

Albany Notes.

THE Central Hudson Company has agreed to lease and operate the Albany Terminal Railroad as soon as it is constructed. The Albany Terminal was incorporated last year to construct a short road from a point near the river front at the upper end of the lumber district to a point near the Tivoli Lake reservoir, there to connect with the Central Hudson. One object of the Terminal Railroad is to facilitate the transportation of lumber in the winter, and another is the building of warehouses at the terminus upon the water front. By the lease of the Albany Terminal the Central Hudson will acquire control of nearly the entire water front of Albany.

IT is learned that the Central Hudson Company is considering plans for the erection of a new and elegant station at Albany. The capital of the State has for some unaccountable reason been shabbily treated by the railroads, and while comfortable, commodious and beautiful structures have been erected elsewhere, Albany is left with what is undoubtedly one of the most inconvenient and ill-arranged stations in the State. It is, in fact, a quarter of a century behind the age, and when we consider the great advance in railroad station building in the last ten years, this is saying a great deal. Not only is the station ill suited to its purpose, but the tracks are exposed to the weather, and no arrangement is provided for bringing trains up to a platform or even to a covered space. The West Shore station and the Delaware & Hudson are upon a lower grade, and are reached by a walk down under the bridge on Quay Street, in a very unsightly situation. At Spencer Street, about four blocks further north, the Company owns a triangle, where a fine union station could be built for all roads, at the same grade, and an arrangement of tracks might be devised by which passengers could reach and leave their trains in greater safety and be protected from the weather. The plan of the new station provides for a substantial building of brick and a tower of sandstone, in

which is to be a large clock of four faces. The building will be in sympathy with the prevailing style of modernized Dutch architecture in Albany.

Baltimore Notes.

SURVEYS are being made for the Lancaster, Cecil & Southern Railroad, which, when completed, will connect with the Lancaster, Oxford & Southern at the Maryland and Pennsylvania line. The new road will also connect with the Baltimore & Ohio at Childs, on Philadelphia Division, and have its terminus at Elkton, Cecil Co., Md. It is stated this new line will be in operation in time to receive business from the Baltimore & Lehigh road, which is being widened to standard gauge. It is also thought, upon the completion of the Belt Line, which will be operated by the Baltimore & Ohio, that the Lancaster, Cecil & Southern; the Lancaster, Oxford & Southern and the Baltimore & Lehigh roads will become a part of the Baltimore & Ohio System.

THE South Baltimore Car Works have just installed a new electric light plant of 35 arc lights of 2,000 candle power each, of the Thomson-Houston System, and contemplate making further improvements by an additional incandescent plant for offices.

THE total amount of tunnel of the Belt Line arched up to February 1 was 3,713 ft., 467 ft. of which was done in January.

PLANS have been completed for the new power house of the City Passenger Cable Railway, to be built at the corner of East and Baltimore streets. The building will be 92 × 170 ft.; the main floor will be the engine room, 82 × 87 ft., 38 ft. high; the boiler room will be 41 × 48 ft.; the coal storage room 41 × 43 ft.; the cable splicing room 82 × 26 ft.; the cable storage room 14 × 40 ft.; the dynamo and tool room 14 × 42 ft. The power house at Eutaw and Lombard streets will be similar in design and dimensions.

THE Beckwith Iron Mills, of Paterson, N. J., are to be removed to Curtis Bay within three months, where, under the name of the Baltimore Rolling Mill Company, steel plates and bar iron will be manufactured. The transfer is the result of efforts made by President William S. Rayner, of the South Baltimore Harbor & Improvement Association. Baltimore capital will be largely invested in the enterprise, but the Beckwiths will continue with the Company. The plant will include the present large iron buildings and machinery of the Company, which will be removed to Curtis Bay, and a second mill for the bar iron manufactory. The expediency of a bar iron mill is proven by the consumption of about 10,000 tons of bar iron at Curtis Bay every year. Hitherto this has been purchased elsewhere. The Beckwith Mills do a large business, and will employ several hundred men. Excepting a few skilled employés that it may be necessary to obtain from other places, Baltimore labor will be employed. President Rayner is much pleased with the acquisition, and the prospect of obtaining the transfer of other large manufacturing industries to Curtis Bay. He says all the Curtis Bay industries are paying well. Much of the success of Curtis Bay he attributes to the energy and management of President McDonald, of the Ryan & McDonald Manufacturing Company, and General Superintendent Carlton, of the South Baltimore Car Company.

THE contract for yokes and general castings for cabling the Blue Line of the Baltimore City Passenger Railroad Company has been awarded by President Bowie to Davies & Thomas, of Catasauqua, Pa., through their Baltimore representatives, Reed, Stickney & Company.

THE location for a new passenger station for the Baltimore & Ohio and Belt roads has been determined upon, and the architects, Messrs. Baldwin & Pennington, are arranging plans for the structure, which will be located on the block bounded by Lombard, Sharp, Pratt, and Howard streets, one square from Camden Station. The new depot will be about 180 × 370 ft.

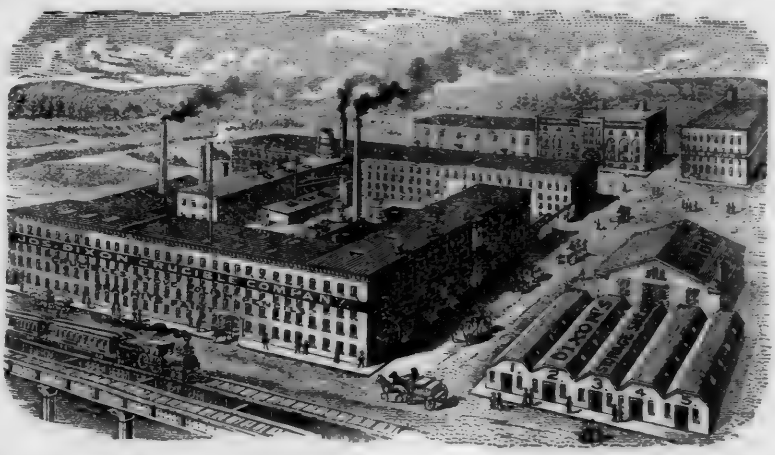
IT will be remembered that some months ago the Baltimore & Ohio purchased a controlling interest in the Pittsburgh & Western Railroad, having also gained control of the Valley Railroad, running from Akron to Cleveland. Arrangements are now being made for the Baltimore & Ohio to assume active charge of the two roads named, operating them as divisions of its system; and as the Akron Division has been completed and is in operation, running from Akron, O., to Chicago Junction, this gives that Company the new line to Chicago via Pittsurgh, which they have had in view for some time. The track and road-bed over this route will be put into first-class condition, and excellent time can be made between Chicago and the East. It is thought the Akron Division, the Valley and the Pittsburgh & Western will form one general division, and be placed under one general superintendent.

THE South Baltimore Car Works have orders to build 500 hopper gondola coal cars for the Baltimore & Ohio, 350 lumber box cars for the same road, and 100 coal cars for the George's Creek Coal & Iron Company, of Baltimore.

Graphite.

THE graphite industry in the country was founded by Joseph Dixon in 1827, when he began the manufacture of black lead crucibles and completely revolutionized the crucible business. All crucibles used at the present day for melting brass, steel, copper, gold, silver, nickel, etc., are made of black lead (the common name for graphite), and by the Dixon process.

His successors, the Joseph Dixon Company, have widely extended the business, manufacturing graphite in many forms both for home sale and export. The works in Jersey City have recently been much enlarged; they are shown in the accompanying engraving. Besides these works the company have a mill for sawing cedar for pencils at Crystal River, Fla. The Dixon Company are miners as well as importers of graphite in all its forms, and use no graphite that they do not mine or prepare. Their mines are located in Ticonderoga, N. Y., and they have every facility in the way of chemists and expensive machinery, etc., necessary for completely freeing



the graphite from the silica, sulphur and other impurities which it contains when it comes from the mines.

The nature of graphite, sometimes called plumbago or black lead, is not generally understood, and therefore its great value in the mechanical arts has not been fully appreciated. Graphite is one of the forms of carbon. It is not affected by heat, cold, acids, alkalies or any known chemicals solvent. It is also the best solid lubricant known to science, a remarkable conductor of heat and electricity. The peculiar qualities of graphite have given it a wide range of usefulness. It is used in the manufacture of lubricants for all purposes—crucibles, stove polish, lead-pencils, foundry facings, electrotyping graphite, graphite paint, etc.

Wood-Working Tools.

THE old shops of the Berry & Orton Company, in Philadelphia, having become too small for the increasing business, the company has lately erected extensive new shops at Twenty-third and Arch streets. The main building is of brick, is five stories in height and is 123 × 80 ft. in size. In addition there is a wing 68 × 45 ft., containing the blacksmith shop, etc.

The offices in the main building are handsomely fitted up, and there is a large drawing-room on the second floor. The shops are connected with the tracks of the Baltimore & Ohio and the Reading railroads.

The Bucyrus Steam-Shovel & Dredge Company.

THE Bucyrus Steam-Shovel & Dredge Company, Bucyrus, O., is much busier than usual just at present. Besides a large number of important orders for steam-shovels and dredges from the United States Government and others, which claim its atten-

tion, the company is also actively engaged in preparing for the removal of its works and business to Milwaukee, Wis. The change of location will be made about July 1 of the current year, and there is a great deal of work to be done before that can be accomplished.

The rapid growth of business has made it clear to the Bucyrus Company that it was a question of but a short time before greater manufacturing facilities would become imperative. The works at Bucyrus are now decidedly cramped, and it is expected that the change, which has been contemplated for some time past, will furnish the desired accommodation. The company has acquired 15 acres of land in South Milwaukee, of which 13 are on the upland, located on the main line of the Chicago & Northwestern Railroad, and the remaining two on Oak Creek where it debouches into Lake Michigan. It is a most advantageous location for the conduction of a business such as that in which the Bucyrus Company is engaged. There will be plenty of room to increase the capacity of its works when this again becomes desirable.

The large upland tract of 13 acres will be used for general manufacturing purposes, and the major part of the buildings will be located there. The Oak Creek location will be used for shipbuilding purposes, the plan being to build there the dredge hulls intended for lake service, also scows, tugs, yachts and other small craft, the machinery for their equipment to be made in the upper works and transported thither over the connecting track. The plans for the buildings are now nearly completed. The capacity of the new works will be double that of the present quarters of the Company.

The shops will all be of modern construction, attractive, substantial and commodious. Special attention will be given to the important questions of light, heating and ventilation. They will be equipped throughout with the most improved machinery and appliances, and are expected, when ready for occupancy, to rank as the finest shops of their kind in the world.

Electricity will be used extensively in the Milwaukee works. They will be lighted by a combination system of arc and incandescent lights. Many of the power applications will be made by electricity, and electric motors will be largely used for various purposes. The Company will also have its own system of water supply and sewage.

In the new works, as in the old, one of the most interesting departments will be that devoted to the manufacture of placer mining outfits, which are used in combination with their steam-shovels and dredges. This system is receiving considerable attention.

The Bucyrus Company has given a practical demonstration of its ability to extract free gold from sand or gravel in dry or wet localities, and the demand for its placer mining machinery is, we are informed, constantly increasing. Its method, it is claimed, saves all the free gold, no matter how fine.

At the Bucyrus Works the Company is just finishing up an elevator dredge for the Government, for use on the Muscle Shoals Canal, on the Tennessee River, the third furnished; also building another elevator dredge for the New Orleans & Northeastern Railroad Company—the second of the kind furnished them—for use in filling up the 26-mile trestle across Lake Pontchartrain. A contract has just been closed with the Plant Investment Company, of New York, for a combination suction and elevator dredge, which will be the only dredge of its kind in this country and one of the very finest ever made. It will be used in the improvement of Port Tampa, Fla.

The Company is building some very heavy machinery for the Suwanee Canal Company, which will be employed for draining the Okefenokee Swamp, in Georgia; also for Breymann Brothers, of Toledo, O., what will be the largest and most powerful dipper dredge in the United States. All of the above are worthy of note as ranking among the largest and finest machines of the kind ever built. A great deal of excavating machinery has been ordered of late from the Company, designed for the phosphate mining industry of the South. This class of machinery is of great variety.

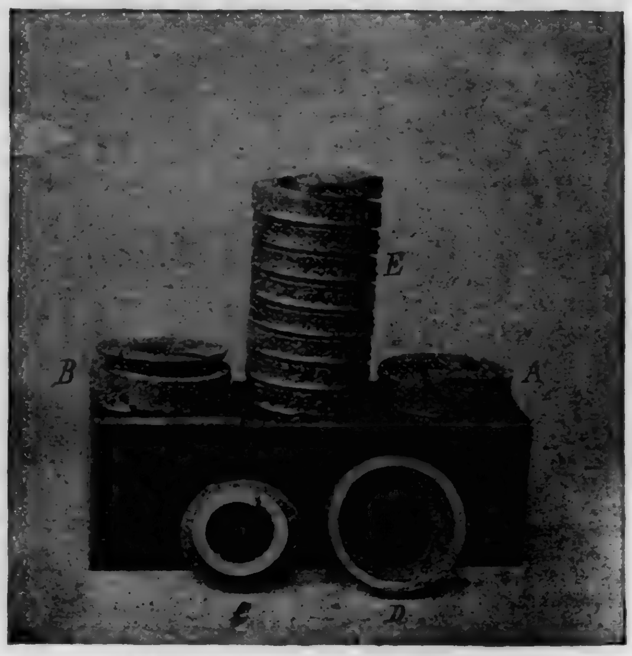
Garlock's Piston-Rod Packing.

THE engraving represents samples of different kinds of rod-packing manufactured by the Garlock Packing Company, of Palmyra, N. Y. *A* represents a specimen of what is called their "elastic ring packing." This, as will be seen, consists of a ring made of fibrous and elastic material, which is cut diagonally, as shown. A number of these rings are placed in the stuffing-box of a rod to be packed, and these are held in place by an ordinary gland.

At *B* what is called the "sectional ring packing" is represented. This consists of a conical upper ring (shown separately at *C*), which fits into the lower ring at *B* (shown separately at *D*), which is made conical internally. Several such pairs of rings are placed in the stuffing-box, and the effect of the pressure of the steam is to contract the internal rings and press them against the rod, and to expand the external ones and make them steam-tight in the stuffing-box.

At *E* a piece of "spiral packing" is shown. This is made in the form of a continuous ring, which can be cut to any desired length.

This packing is very expansive, and therefore the glands should be left quite loose and should be seldom tightened with a



GARLOCK'S PISTON-ROD PACKING.

wrench. The nuts should be screwed up with the fingers alone, which is sufficient in most cases. Should it leak water when starting, it need not be tightened, as it will soon stop leaking when the packing is expanded by the heat.

General Notes.

THE Columbus Bridge Company, Columbus, O., has just taken a contract from the Baltimore & Ohio Company for three plate-girder spans 76 ft. long, at Wilmington, Del.; also for two truss spans of 103 ft. each, at Lancaster, O., for the Columbus, Hocking Valley & Toledo Railroad.

THE Chicago & Northwestern Company has contracted with the Hall Signal Company, of New York, to equip 33 miles of the Milwaukee Division with the Hall electric signals. The same signals are to be applied to portions of the Wisconsin and Galena divisions, making in all 87 miles of road to be so equipped.

AN order has recently been placed with the firm of R. Hoe & Company, of New York, for a quadruple rotary printing-press, for the *Dundee Courier*, of Dundee, Scotland. This will be the first press of the class sent to Great Britain; it will be capable of printing 50,000 eight-page papers an hour, and can print a variety of sizes from 4 up to 24 pages.

TERMS of consolidation have been arranged between the Edison and the Thomson-Houston Electric companies, two of the largest concerns engaged in electric business. The consolidated corporation is to have a capital stock of $50,000,000, of which $15,000,000 will be exchanged for the present stock of the Edison Company and $18,400,000 for that of the Thomson-Houston Company, leaving $16,600,000 for future use in extending the business. Of the new stock $10,000,000 will be preferred and the rest common stock. Of the preferred, $4,000,000 will be exchanged for Thomson-Houston preferred stock and the balance held; of the common, $14,400,000 will be issued for Thomson-Houston common stock and $15,000,000 for Edison stock, leaving $10,600,000 in the treasury. The new company will be a very strong one, though capitalized at a very high rate.

THE Morgan Iron Works, New York, are building new engines and boilers for the Pacific Mail Company's steamer *City of Para*. The engines are of the triple-expansion type, with

cylinders 28 in., 44 in. and 70 in. diameter and 48 in. stroke. There are six boilers, each 12 ft. 2 in. in diameter and 11 ft. 6 in. long.

THE Pennsylvania Company's shops, at Fort Wayne, are to build several ten-wheel passenger engines; they will have 19 × 24-in. cylinders, 68-in. drivers, and the boilers will be 62 in. diameter of barrel.

THE Rogers Locomotive Works, Paterson, N. J., is building 10 heavy freight engines for the Central Railroad of New Jersey.

THE A. French Spring Company, Pittsburgh, has prepared a very convenient blank for ordering elliptic springs. It has sketches of the different kind of ends and bands wanted, and a blank for entering the dimensions desired, so that the whole order can be taken in at a glance, and there seems no possibility of a mistake or misunderstanding. The form of the blank is copyrighted.

THE rapidly increasing business of the Consolidated Car-Heating Company has made it is necessary to enlarge the plant. Heretofore the factory occupied has been leased, but recently the company purchased a tract of land at the north end of Albany, and has already let contracts for the erection of a new factory and warehouse. The first floor of the new building will be used exclusively for a shipping room and wareroom for all finished material. A portion of the second floor will be used for offices and the remainder for lathes. The third floor will be used for drills, brass lathes and handwork in putting up their various apparatus. The fourth floor will be used exclusively for tests and experimental work. This floor will especially be equipped so that all apparatus furnished by the Company will be thoroughly tested before leaving the factory, so that defects in all material supplied will be reduced to a minimum. The factory will be equipped with the latest and best machinery for doing their work, the greater part of which is special. Aside from this will be the engine house and auxilliary buildings. The contractors for the building are already at work, and the buildings will be rapidly pushed to completion. The Consolidated Car-Heating Company will probably occupy the new buildings on or about June 1 next.

THE Grant Machine Tool Works, Fitchburg, Mass., have a new building 100 × 30 ft. in size, equipped with new machinery, including special tools for steel forgings. For the present the works are occupied in making steel balls by a new process invented by Messrs J. J. and R. H. Grant. There are now 10 machines at work making these balls, and 20 more have been ordered, while four grinding machines for finishing them are ready. About 400,000 per week can be turned out, and the firm has received an offer from England for 10,000,000 for bicycle bearings. Larger ones for street car bearings are to be made, and other specialties in steel forgings will be manufactured.

THE Chicago, Rock Island & Pacific Company recently let contracts for 500 box cars, 500 furniture cars, and 200 stock cars. The Wells & French Company, in Chicago, will build 700 of these cars, and the remaining 500 will be built by the Peninsular Car Company, in Detroit.

THE Florida Car Manufacturing Company has been organized at Green Cove Springs, Fla., with $150,000 capital. It is apparently a reorganization of the old firm of Blaine Brothers.

THE Delaware River Iron Ship-Building & Engine Works, Chester, Pa., recently launched the ferryboat *Washington* for the Pennsylvania Railroad Company. The *Washington* is 206 ft. long, 65 ft. over guards and 17 ft. deep, and is almost a duplicate of the *Cincinnati*, recently put in service by the same company. She will have a propeller at each end, driven by two compound engines of the Canfield type. The engines will be built and put in at the Pennsylvania shops at Hoboken.

THE Keystone Bridge Company in Pittsburgh has the contract for building the new elevated railroad in Chicago. This road will have a total length of about 8¼ miles.

THE Southern Pacific Company has given orders for the building of 750 new freight cars in the Sacramento shops.

THE Cooke Locomotive Works, Paterson, N. J., are building several ten-wheel freight engines, with 18 × 24-in. cylinders, for the International & Great Northern, and 25 Mogul engines, with 18 × 24-in. cylinders, for the Chicago, St. Paul & Kansas City Railroad.

PERSONALS.

EDWARD N. PIKE has established an office in Meriden, Conn., as a civil and consulting engineer.

A. W. WILDES, of Skowhegan, has been appointed Railroad Commissioner of Maine for a second term.

H. DEB. PARSONS, Consulting Mechanical Engineer, has removed his office from 35 Broadway to 22 William Street, New York City.

PROFESSOR L. M. HAUPT has resigned his position in the University of Pennsylvania, and will engage in active practice as a civil engineer.

ISAAC D. BARTON, recently General Superintendent of the Long Island Railroad, has been appointed General Manager of the New York & New England Railroad.

N. W. SAMPLE, for some time past Superintendent of Motive Power of the Denver & Rio Grande Railroad, has been appointed General Superintendent of the road.

ALFRED WALTER, for some time past General Superintendent of the Baltimore & Ohio, has been appointed General Manager of the New York, Lake Erie & Western Railroad.

J. L. VAN ORNUM has been appointed Chief Topographer to the International Commission in charge of the survey of the boundary line between the United States and Mexico. His headquarters will be at El Paso, Texas.

W. G. RICHARDS has resigned his position as Superintendent of the American Steel Wheel Company. He has had long experience in wheel making, including several years' service in the Allen Paper Car Wheel Works at Hudson.

ROBERT H. SAYRE, now Vice-President of the Lehigh Valley Company, will be, under the new leases, Third Vice-President of the Philadelphia & Reading Company. He will have charge of construction and maintenance of way, a work for which he is especially well fitted.

JAMES F. HOBART, for some time past Editor of the *Journal of Railroad Appliances*, has resigned that position, and will shortly return to Minneapolis as Editor of the *Northwestern Mechanic*, with which paper he was formerly connected. Mr. Hobart is well known as an excellent writer on mechanical topics.

CHARLES HANSEL, Consulting Engineer of the Railroad Commission of Illinois, has been commissioned to promote the interests of the Columbian Exposition in Europe by urging railroad companies and manufacturers to become exhibitors. Mr. Hansel will sail for Europe soon, and expects to spend several months abroad.

G. W. CUSHING has been appointed General Superintendent of the American Steel Wheel Company in charge of the Mechanical Department of the Company at South Boston; he will also have charge of the new works about to be erected in New Jersey. Mr. Cushing is well known from his long service as Superintendent of Motive Power on a number of important lines.

RICHARD P. MORGAN announces that, in connection with his son, D. C. Morgan, he has established an office as Consulting Engineer and Railroad Expert at Dwight, Ill. Mr. Morgan has been known as an engineer of standing for a number of years, and has conducted several important examinations of railroad property. Some years ago he made an exhaustive report on the Union and Central Pacific railroads to the Government Pacific Railroad Commission. He also served for several years as Engineer of the Illinois Railroad & Warehouse Commission. Mr. D. C. Morgan is also well known as an engineer.

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tion, the company is also actively engaged in preparing for the removal of its works and business to Milwaukee, Wis. The change of location will be made about July 1 of the current year, and there is a great deal of work to be done before that can be accomplished.

The rapid growth of business has made it clear to the Bucyrus Company that it was a question of but a short time before greater manufacturing facilities would become imperative. The works at Bucyrus are now decidedly cramped, and it is expected that the change, which has been contemplated for some time past, will furnish the desired accommodation. The company has acquired 15 acres of land in South Milwaukee, of which 13 are on the upland, located on the main line of the Chicago & Northwestern Railroad, and the remaining two on Oak Creek where it debouches into Lake Michigan. It is a most advantageous location for the conduction of a business such as that in which the Bucyrus Company is engaged. There will be plenty of room to increase the capacity of its works when this again becomes desirable.

The large upland tract of 13 acres will be used for general manufacturing purposes, and the major part of the buildings will be located there. The Oak Creek location will be used for shipbuilding purposes, the plan being to build there the dredge hulls intended for lake service, also scows, tugs, yachts and other small craft, the machinery for their equipment to be made in the upper works and transported thither over the connecting track. The plans for the buildings are now nearly completed. The capacity of the new works will be double that of the present quarters of the Company.

The shops will all be of modern construction, attractive, substantial and commodious. Special attention will be given to the important questions of light, heating and ventilation. They will be equipped throughout with the most improved machinery and appliances, and are expected, when ready for occupancy, to rank as the finest shops of their kind in the world.

Electricity will be used extensively in the Milwaukee works. They will be lighted by a combination system of arc and incandescent lights. Many of the power applications will be made by electricity, and electric motors will be largely used for various purposes. The Company will also have its own system of water supply and sewage.

In the new works, as in the old, one of the most interesting departments will be that devoted to the manufacture of placer mining outfits, which are used in combination with their steam-shovels and dredges. This system is receiving considerable attention.

The Bucyrus Company has given a practical demonstration of its ability to extract free gold from sand or gravel in dry or wet localities, and the demand for its placer mining machinery is, we are informed, constantly increasing. Its method, it is claimed, saves all the free gold, no matter how fine.

At the Bucyrus Works the Company is just finishing up an elevator dredge for the Government, for use on the Muscle Shoals Canal, on the Tennessee River, the third furnished; also building another elevator dredge for the New Orleans & Northeastern Railroad Company—the second of the kind furnished them—for use in filling up the 26-mile trestle across Lake Pontchartrain. A contract has just been closed with the Plant Investment Company, of New York, for a combination suction and elevator dredge, which will be the only dredge of its kind in this country and one of the very finest ever made. It will be used in the improvement of Port Tampa, Fla.

The Company is building some very heavy machinery for the Suwanee Canal Company, which will be employed for draining the Okefenokee Swamp, in Georgia; also for Breymann Brothers, of Toledo, O., what will be the largest and most powerful dipper dredge in the United States. All of the above are worthy of note as ranking among the largest and finest machines of the kind ever built. A great deal of excavating machinery has been ordered of late from the Company, designed for the phosphate mining industry of the South. This class of machinery is of great variety.

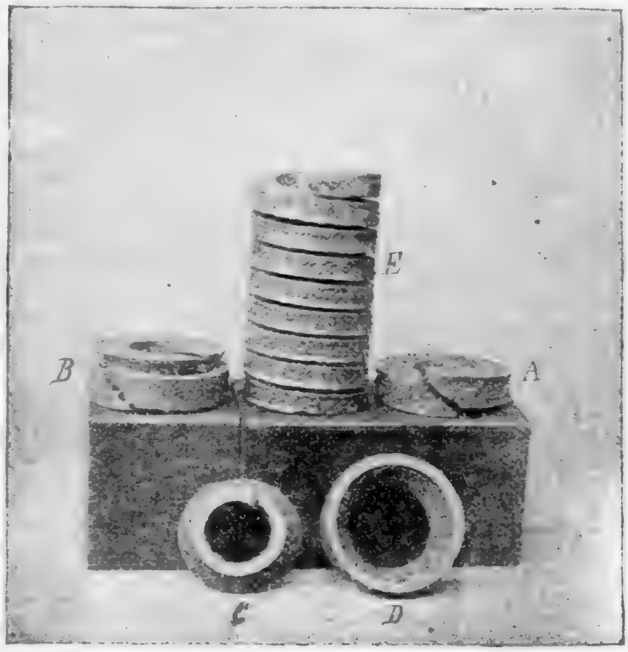
Garlock's Piston-Rod Packing.

The engraving represents samples of different kinds of rod-packing manufactured by the Garlock Packing Company, of Palmyra, N. Y. *A* represents a specimen of what is called their "elastic ring packing." This, as will be seen, consists of a ring made of fibrous and elastic material, which is cut diagonally, as shown. A number of these rings are placed in the stuffing-box of a rod to be packed, and these are held in place by an ordinary gland.

At *B* what is called the "sectional ring packing" is represented. This consists of a conical upper ring (shown separately at *C*), which fits into the lower ring at *B* (shown separately at *D*), which is made conical internally. Several such pairs of rings are placed in the stuffing-box, and the effect of the pressure of the steam is to contract the internal rings and press them against the rod, and to expand the external ones and make them steam tight in the stuffing-box.

At *E* a piece of "spiral packing" is shown. This is made in the form of a continuous ring, which can be cut to any desired length.

This packing is very expansive, and therefore the glands should be left quite loose and should be seldom tightened with a



GARLOCK'S PISTON-ROD PACKING.

wrench. The nuts should be screwed up with the fingers alone, which is sufficient in most cases. Should it leak water when starting, it need not be tightened, as it will soon stop leaking when the packing is expanded by the heat.

General Notes.

The Columbus Bridge Company, Columbus, O., has just taken a contract from the Baltimore & Ohio Company for three plate-girder spans 76 ft. long, at Wilmington, Del.; also for two truss spans of 103 ft. each, at Lancaster, O., for the Columbus, Hocking Valley & Toledo Railroad.

The Chicago & Northwestern Company has contracted with the Hall Signal Company, of New York, to equip 33 miles of the Milwaukee Division with the Hall electric signals. The same signals are to be applied to portions of the Wisconsin and Galena divisions, making in all 87 miles of road to be so equipped.

An order has recently been placed with the firm of R. Hoe & Company, of New York, for a quadruple rotary printing-press, for the *Dundee Courier*, of Dundee, Scotland. This will be the first press of the class sent to Great Britain; it will be capable of printing 50,000 eight-page papers an hour, and can print a variety of sizes from 4 up to 24 pages.

Terms of consolidation have been arranged between the Edison and the Thomson-Houston Electric companies, two of the largest concerns engaged in electric business. The consolidated corporation is to have a capital stock of $50,000,000, of which $15,000,000 will be exchanged for the present stock of the Edison Company and $18,400,000 for that of the Thomson-Houston Company, leaving $16,600,000 for future use in extending the business. Of the new stock $10,000,000 will be preferred and the rest common stock. Of the preferred, $4,000,000 will be exchanged for Thomson-Houston preferred stock and the balance held; of the common, $14,400,000 will be issued for Thomson-Houston common stock and $15,000,000 for Edison stock, leaving $10,600,000 in the treasury. The new company will be a very strong one, though capitalized at a very high rate.

The Morgan Iron Works, New York, are building new engines and boilers for the Pacific Mail Company's steamer *City of Para*. The engines are of the triple-expansion type, with

linders 28 in., 44 in. and 70 in. diameter and 48 in. stroke. re are six boilers, each 12 ft. 2 in. in diameter and 11 ft. 6 ong.

THE Pennsylvania Company's shops, at Fort Wayne, are to build several ten-wheel passenger engines; they will have 24-in. cylinders, 68-in. drivers, and the boilers will be 62 diameter of barrel.

THE Rogers Locomotive Works, Paterson, N. J., is building 10 heavy freight engines for the Central Railroad of New Jersey.

THE A. French Spring Company, Pittsburgh, has prepared a very convenient blank for ordering elliptic springs. It has sketches of the different kind of ends and bands wanted, and a blank for entering the dimensions desired, so that the whole order can be taken in at a glance, and there seems no possibility of a mistake or misunderstanding. The form of the blank is copyrighted.

THE rapidly increasing business of the Consolidated Car-Heating Company has made it is necessary to enlarge the plant. Heretofore the factory occupied has been leased, but recently the company purchased a tract of land at the north end of Albany, and has already let contracts for the erection of a new factory and warehouse. The first floor of the new building will be used exclusively for a shipping room and wareroom for all finished material. A portion of the second floor will be used for offices and the remainder for lathes. The third floor will be used for drills, brass lathes and handwork in putting up their various apparatus. The fourth floor will be used exclusively for tests and experimental work. This floor will especially be equipped so that all apparatus furnished by the Company will be thoroughly tested before leaving the factory, so that defects in all material supplied will be reduced to a minimum. The factory will be equipped with the latest and best machinery for doing their work, the greater part of which is special. Aside from this will be the engine house and auxiliary buildings. The contractors for the building are already at work, and the buildings will be rapidly pushed to completion. The Consolidated Car-Heating Company will probably occupy the new buildings on or about June 1 next.

THE Grant Machine Tool Works, Fitchburg, Mass., have a new building 100 × 30 ft. in size, equipped with new machinery, including special tools for steel forgings. For the present the works are occupied in making steel balls by a new process invented by Messrs J. J. and R. H. Grant. There are now 10 machines at work making these balls, and 20 more have been ordered, while four grinding machines for finishing them are ready. About 400,000 per week can be turned out, and the firm has received an offer from England for 10,000,000 for bicycle bearings. Larger ones for street car bearings are to be made, and other specialties in steel forgings will be manufactured.

THE Chicago, Rock Island & Pacific Company recently let contracts for 500 box cars, 500 furniture cars, and 200 stock cars. The Wells & French Company, in Chicago, will build 700 of these cars, and the remaining 500 will be built by the Peninsular Car Company, in Detroit.

THE Florida Car Manufacturing Company has been organized at Green Cove Springs, Fla., with $150,000 capital. It is apparently a reorganization of the old firm of Blaine Brothers.

THE Delaware River Iron Ship-Building & Engine Works, Chester, Pa., recently launched the ferryboat *Washington* for the Pennsylvania Railroad Company. The *Washington* is 206 ft. long, 65 ft. over guards and 17 ft. deep, and is almost a duplicate of the *Cincinnati*, recently put in service by the same company. She will have a propeller at each end, driven by two compound engines of the Canfield type. The engines will be built and put in at the Pennsylvania shops at Hoboken.

THE Keystone Bridge Company in Pittsburgh has the contract for building the new elevated railroad in Chicago. This road will have a total length of about 8½ miles.

THE Southern Pacific Company has given orders for the building of 750 new freight cars in the Sacramento shops.

THE Cooke Locomotive Works, Paterson, N. J., are building several ten-wheel freight engines, with 18 × 24-in. cylinders, for the International & Great Northern, and 25 Mogul engines, with 18 × 24-in. cylinders, for the Chicago, St. Paul & Kansas City Railroad.

PERSONALS.

EDWARD N. PIKE has established an office in Meriden, Conn., as a civil and consulting engineer.

A. W. WILDES, of Skowhegan, has been appointed Railroad Commissioner of Maine for a second term.

H. DEB. PARSONS, Consulting Mechanical Engineer, has removed his office from 35 Broadway to 22 William Street, New York City.

PROFESSOR L. M. HAUPT has resigned his position in the University of Pennsylvania, and will engage in active practice as a civil engineer.

ISAAC D. BARTON, recently General Superintendent of the Long Island Railroad, has been appointed General Manager of the New York & New England Railroad.

N. W. SAMPLE, for some time past Superintendent of Motive Power of the Denver & Rio Grande Railroad, has been appointed General Superintendent of the road.

ALFRED WALTER, for some time past General Superintendent of the Baltimore & Ohio, has been appointed General Manager of the New York, Lake Erie & Western Railroad.

J. L. VAN ORNUM has been appointed Chief Topographer to the International Commission in charge of the survey of the boundary line between the United States and Mexico. His headquarters will be at El Paso, Texas.

W. G. RICHARDS has resigned his position as Superintendent of the American Steel Wheel Company. He has had long experience in wheel making, including several years' service in the Allen Paper Car Wheel Works at Hudson.

ROBERT H. SAYRE, now Vice-President of the Lehigh Valley Company, will be, under the new leases, Third Vice-President of the Philadelphia & Reading Company. He will have charge of construction and maintenance of way, a work for which he is especially well fitted.

JAMES F. HOBART, for some time past Editor of the *Journal of Railroad Appliances*, has resigned that position, and will shortly return to Minneapolis as Editor of the *Northwestern Mechanic*, with which paper he was formerly connected. Mr. Hobart is well known as an excellent writer on mechanical topics.

CHARLES HANSEL, Consulting Engineer of the Railroad Commission of Illinois, has been commissioned to promote the interests of the Columbian Exposition in Europe by urging railroad companies and manufacturers to become exhibitors. Mr. Hansel will sail for Europe soon, and expects to spend several months abroad.

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WARD NICHOLS. He was for a number of years in the Machinery Department of the Erie Railroad, and when the Brooks Locomotive Works were organized, in 1869, he was made Secretary and Treasurer. When Mr. Brooks died, in 1887, Mr. Hinman was chosen Vice-President. He has served for three years also as Mayor of Dunkirk, and is now President of the Board of Education, of the Water Commission of the city, and of the Lake Shore National Bank. Mr. Hinman's successor as Vice-President is R. J. GROSS, who for nine years past has been Traveling Agent of the Works, and who had previously seen service on the Grand Trunk, the Denver & Rio Grande, and the Erie roads.

OBITUARY.

EDWIN S. RIGGS died at his home in Brooklyn, N. Y., February 2. Mr. Riggs was for a number of years connected with the firm of E. S. Greeley & Company, and for 12 years past had been the Manager of the Railroad Department of that firm. He was also a Director and Assistant Treasurer of the Company.

PROFESSOR WILLIAM GREY PECK, who died at Greenwich, Conn., February 7, aged 72 years, was born in Litchfield, Conn., and graduated from West Point in 1844. After 11 years' service in the Army he resigned, and was for a time Professor of Civil Engineering in the University of Michigan. In 1857 he was called to Columbia College, in New York, as Professor of Mathematics, and remained at Columbia until his death. He was the author of several mathematical works.

THOMAS T. TASKER, who died in Philadelphia, January 27, aged 92 years, was born in Yorkshire, England, but came to this country when 19 years old. About 1819 he established a small shop for the manufacture of stoves in partnership with Stephen Morris, in Philadelphia. Their business was gradually increased, and when gas was introduced they began the manufacture of gas-pipe, forming the nucleus from which the Pascal Iron Works have grown up to their present extent. Mr. Tasker retired from active business a number of years ago, leaving the management of the works chiefly in the hands of his son. He was an active and public-spirited citizen, and was for many years a member of the Franklin Institute and of the Academy of Natural Sciences in Philadelphia.

WILLIAM SMITH, who died at his residence in Boston, January 19, was born at South Berwick, Me., in 1827. In 1849 he entered the repair shops of the Boston & Maine road as a machinist, and had served continuously on that road until the time of his death. He was for 23 years a locomotive engineer, and for six years Engine Dispatcher; in 1877 ne was appointed Master Mechanic of the road, which position he has since held, his title being changed to Superintendent of Motive Power some years ago. Mr. Smith was a practical man and a very energetic officer. For some time past he had been engaged in the difficult work of securing as much uniformity as possible in the system under his charge, which was made up of many different roads owning different kinds of rolling stock.

JAMES T. FURBER, who died in Boston, January 27, was born in New Hampshire. He began his railroad work on the Boston & Maine as Station Agent at Great Falls. He was afterward for several years Agent of the Erie Railroad at Jersey City, but about 1868 returned to the Boston & Maine as Agent at Lawrence, Mass. From that position he was promoted to be General Freight Agent, and in 1873 he was made General Superintendent of the railroad. He retained that position under all the changes and consolidations of the past few years, remaining the chief executive officer of the Boston & Maine system. Last year he was elected Vice-President of the company also. Mr. Furber was noted for his ability as a traffic manager, and for some years past has been one of the most prominent railroad officers in New England.

JAMES SEDGLEY, who died in Washington, January 11, aged 68 years, was born in Limerick, Me., and at an early age learned the trade of a machinist. He entered the service of the Northern (New Hampshire) Railroad in the shops at Concord about 1850, and a few years later was appointed Master Mechanic. In 1865 he was appointed General Master Mechanic of the Michigan Southern & Northern Indiana Railroad, and retained that position until the consolidation of the road with the Lake Shore, when he was made Superintendent of Motive Power of the consolidated road. He remained in that office until 1884, when he retired on account of failing health, and since that time has lived in Washington. Mr. Sedgley was an active member of the Master Mechanics' Association, and did much to forward its interests; he was for some time Vice-President of the Association.

CAPTAIN GEORGE C. DICKINSON died at his residence in Cobham, Albemarle Co., Va., January 24, of pneumonia, after a short illness. He was 60 years of age, and was born in New York City, but at an early age removed to Virginia. He received a careful training as a mining and civil engineer, and was employed on a number of Southern railroads, serving several years on the Chesapeake & Ohio and also for four years on the Baltimore & Ohio. At the breaking out of the War he entered the Confederate Army as Captain of Engineers, and served in the Engineer Corps throughout the War. Since 1865 he had been engaged on railroad surveys in Virginia, and was also for several years connected with the Hudson Suspension Bridge & New England Railroad Company, and was Engineer in charge of all the preliminary work done on that company's proposed bridge near Peekskill and Fort Montgomery. For two years past he had been engaged in the service of a line intended to develop the coal-mines of the upper Shenandoah Valley and of Albemarle County. Captain Dickinson was a member for a number of years of the American Society of Civil Engineers. He was an engineer of ability, and was highly esteemed by his friends.

DR. THOMAS STERRY HUNT, the famous geologist, died in New York, February 12, of disease of the heart. He was born in Norwich, Conn., in 1826, of an old New England family. In 1845 he studied chemistry and mineralogy under Professor Benjamin Silliman, Sr., at Yale College. Two years later he was appointed Chemist and Mineralogist to the Geological Survey of Canada, a position which he held for more than 25 years. He was the first person to make a systematic attempt to subdivide and classify geologically the stratiform crystalline rocks. His contributions to scientific literature were numerous. In 1887 he published "A New Basis for Chemistry," which was translated into French. Among his other important volumes were "Azoic Rocks," "Chemical and Geological Essays," "Mineral Physiology and Physiography," and "Systematic Mineralogy." He was one of the organizers of the International Geological Congress, and was a vice-president of the congresses of Paris, 1878; Bologna, 1881 and London, 1888. In connection with the great industrial exhibitions Dr. Hunt was a member of the international juries at Paris, in 1855 and 1867, and at the Centennial Exhibition in 1876. For the past three years his health had been very poor. He was a member of numerous scientific societies both in this country and Europe.

EDWARD M. REED died in New Haven, Conn., February 13, aged 70 years. He was born in Lancaster County, Pa., and had been a railroad man for nearly 50 years, having begun work as a locomotive engineer on the Baltimore & Ohio in 1843. He had already learned the machinist's trade and a year or two later was Master Mechanic of the Philadelphia & Reading shop at Port Richmond. In 1846 he went to Cuba to take charge of a railroad there, but two years later returned to this country and was made Master Mechanic of the old Hartford & New Haven Railroad. In 1853 he was made Superintendent and remained in charge of the road until it was consolidated with the New York & New Haven, when he was appointed General Superintendent of the consolidated line. In 1874 he was chosen Vice-President, and has since been the chief executive officer of the company.

Mr. Reed was a vigorous and active officer, a hard worker and thoroughly acquainted with the business of his road down to the smallest details. He was especially well posted in the mechanical department, as might be expected from his early training, and was inclined to be rather conservative in his views. He was completely identified with the New Haven road, and his individuality was strongly impressed upon its management.

PROCEEDINGS OF SOCIETIES.

Northwest Railroad Club.—At the regular meeting, in St. Paul, December 22, Mr. J. O. Pattee described some experiments made by him to determine the cause of steel sheets breaking when being flanged. These, he thought, proved the susceptibility of steel to injury when worked at a blue heat.

The subject of cracks in fire-box sheets was discussed at some length by Messrs. Lewis, McIntosh and others.

Southern Society of Civil Engineers.—At the annual meeting in Jacksonville, Fla., January 19, the Committee on Legislation presented an outline of a bill for the appointment of State engineers.

Papers were read on Railroad Location, by M. J. Lynch, and on Highways, by J. E. Bozeman.

The officers elected were: President, J. E. Bozeman, Selma, Ala.; Secretary J. deB. Kops, Savannah, Ga.

Ohio Society of Civil Engineers.—At the annual meeting in Columbus, O., January 19, a committee was appointed to report on a plan for employing a secretary to devote his entire time to the work of the Society and to collecting a library.

A draft of a bill for licensing surveyors was presented, discussed and finally brought into shape, and a committee was appointed to bring it before the Legislature.

Professor A. A. Graham read a paper on the western boundaries of the State.

Owing to the shortness of the time, a number of papers were read by title only.

The following officers were elected: President, C. H. Burgess, Cleveland; Vice-President, L. W. Matthewson, Cincinnati; Secretary and Treasurer, C. A. Judson, Sandusky.

Franklin Institute.—At the annual meeting in Philadelphia, January 20, the following elections were announced: President, Joseph M. Wilson; Vice-President, Edward Longstreth; Secretary, Dr. William H. Wahl; Treasurer, Samuel Sartain; Auditor, W. A. Cheyney; Managers, John E. Codman, George V. Cresson, Edwin J. Houston, Enoch Lewis, John Lucas, S. P. Sadtler, W. H. Thorne, John C. Trautwine, Jr.; Committee on Science and the Arts, L. L. Cheney, Arthur Church, C. M. Cresson, James Christie, D. E. Crosby, J. M. Emanuel, J. L. Gill, Jr., J. F. Haskins, Carl Hering, S. R. Marshall, William McDevitt, C. E. Ronaldson, Samuel Sartain, T. C. Smith and S. L. Wiegand.

Engineers' Society of Western Pennsylvania.—The twelfth annual meeting of this Society was held in its rooms in Pittsburgh on January 19, Mr. T. P. Roberts, the President, in the chair. The Secretary's report showed a membership of 370. The following papers had been read during the year: Slow Combustion Construction of Buildings, by H. B. Chess; Bridge Designs, by H. L. Lewis; Steam Economy in Rolling Mill Engine Practice, by D. Ashworth; Hydraulic Cements, by A. E. Hunt; Bridge Details, by E. Swenson.

The following officers were elected for the ensuing year: President, Alfred E. Hunt; Vice-Presidents, one year, Phineas Barnes; two years, Charles Davis; Directors, Robert Munroe, G. W. G. Ferris; Secretary, R. N. Clark; Treasurer, A. E. Frost.

The annual banquet was given at the Duquesne Club, in Pittsburgh, on January 28, and 103 members and guests were present. A number of addresses were made, and the occasion was a very enjoyable one.

The menu cards for the banquet were printed on double sheets of aluminum 0.001 in. thick; these sheets were rolled by the Pittsburgh Reduction Company especially for this purpose.

American Society of Civil Engineers.—At the regular meeting, February 3, the deaths of three members—E. P. Butts, George C. Dickinson and A. O. Wilson—were announced.

A paper by F. A. Calkins on Brick Manufacture and Brick Pavements was read and discussed.

The following elections were announced:

Members: J. R. Carter, Lincoln, Ala.; Knud S. Riser, Clinton, Ia.; A. W. Robinson, Bucyrus, O.; W. H. G. Temple, Providence, R. I.; Anthony Victorin, Watervliet Arsenal, West Troy, N. Y.; J. Wainwright, Pittsburgh, Pa.; John C. Wait, Cambridge, Mass.; Charles A. Hague, New York.

Associate Members: Samuel E. Barney, Jr., New Haven, Conn.; Allan D. Conover, Madison, Wis.; William B. Ewing, Charles A. Hasbrouck, Chicago, Ill.; George A. Kyle, Olympia, Wash.; Paul Voorhees, Buffalo, N. Y.; Edward H. Connor, New York.

American Association of Inventors and Manufacturers.—The second annual meeting—the first one after the organization—was held in Washington, January 19. A number of addresses were made, and committees were appointed to arouse interest among manufacturers and inventors and to secure contributions for the funds of the Society. The old standing committees were continued for another year. Dr. R. J. Gatling was reelected President, and Mr. George C. Maynard was chosen Secretary and Treasurer.

Western Society of Engineers.—At the regular meeting, in Chicago, February 3, it was announced that Mr. Isham Randolph was elected President.

The Committee on the Railroad Problem in Chicago asked more time to complete its report. A minority report from the Committee on Highway Bridge Legislation was presented and discussed at some length.

A communication from Commissioner of Public Works Aldrich, of Chicago, asking the Society to appoint three of its members to examine into the work on the new water-works tunnel and report the facts in the case, called out a long and somewhat sharp discussion. Finally a resolution was adopted referring the matter to the Board of Directors, with instructions to present the names of ten competent engineers to the Commissioners as fitted to do the work proposed.

Central Railroad Club.—At the annual meeting, in Buffalo, January 27, several amendments to the Rules of Interchange were presented and discussed, and a proposed new standard wheel-gauge was presented.

Mr. P. H. Griffin read an interesting paper on Car Wheels and Brake Service, showing the injury done to wheels by improper use of brakes.

The following officers were elected: President, Eugene Chamberlain; Vice-President, T. B. Griffith; Secretary and Treasurer, S. W. Spear.

New York Railroad Club.—At the regular meeting, February 18, there was a large attendance. The first part of the session was given up to a discussion on amendments proposed to the Rules of Interchange.

The subject of Counterbalancing Locomotives was then brought up, and an interesting discussion followed, in which a number of members took part.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, February 16, Mr. William Metcalf read a long and interesting paper on Smoke. This was followed by a general discussion, in which Messrs. H. K. Porter, Koch, Dr. Sutton and others took part.

Northwest Railroad Club.—At the regular meeting, on February 2, several papers on Car Roofs were presented, describing different patterns of roofs. Some interesting statements of experience were made.

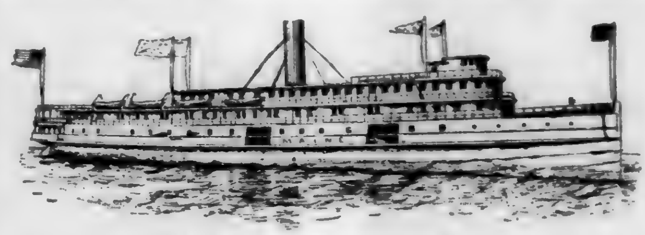
American Institute of Mining Engineers.—The annual meeting was held in Baltimore, beginning February 16. At the first session the President, Mr. John Birkenbine, delivered the annual address.

Meetings for reading of papers and discussions were held on February 17, and the concluding business session on February 20. On February 18 the members went to Annapolis, and in the evening the annual dinner was given. February 19 and the morning of February 20 were given up to excursions to various points of interest in the vicinity of Baltimore.

A large number of interesting papers were presented at this meeting.

NOTES AND NEWS.

New Sound Steamers.—The accompanying illustration, from the *Seaboard*, shows the new steamer *Maine*, one of two which the Harlan & Hollingsworth Company at Wilmington, Del., is building for the Providence & Stonington Steamship Company, for service on Long Island Sound. The boats will be very handsomely fitted up for passengers and will also have large freight carrying capacity.



THE NEW SOUND STEAMER "MAINE."

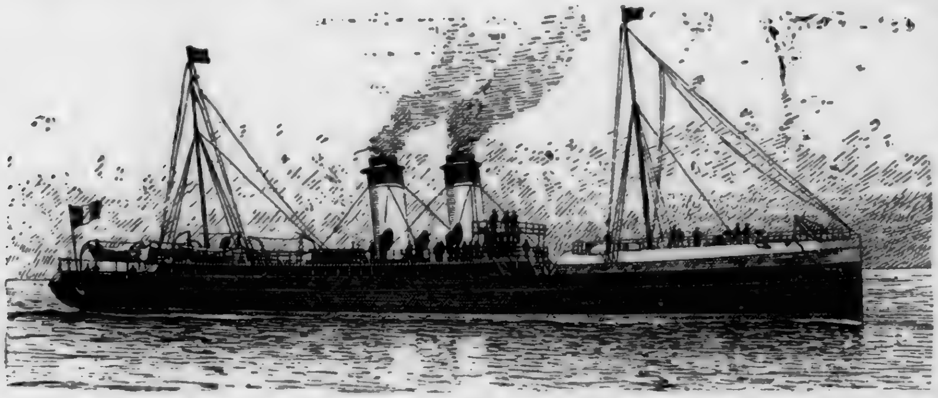
The *Maine* is 310 ft. long over all; 302 ft. 7 in. on waterline; beam, molded, 44 ft.; width over guards, 60 ft.; draft, 12 ft. 6 in. The main saloon will be 243 ft. long, and the dining-room will be on the upper deck, instead of below, as in most of the Sound boats. The boat will be lighted by electricity throughout.

The boat has a single screw, four-bladed and 13 ft. 6 in. in diameter. This screw is driven by a vertical, inverted triple-expansion engine, with high-pressure cylinder 28 in., intermediate 45 in. and two low-pressure cylinders each 51 in. in

diameter, all being 42 in. stroke. There are four boilers of the Scotch type, each 13 ft. 6 in. in diameter and 11 ft. 6 in. long, each having three corrugated furnaces; they will work at 160 lbs. pressure, and the fire-room is arranged for forced draft.

The second boat is named *New Hampshire*, and is a duplicate of the *Maine* in all respects.

Recent Progress in Car Construction.—In a paper recently read before the Western Railroad Club, Mr. D. L. Barnes describes the most notable changes in car construction and design, and notes the great difference in strength and carrying capacity between our present cars and those of a few years ago. The present tendency is to substitute steel and iron for wood, but Mr. Barnes does not believe that an all-steel car will be generally adopted, although he gives plans of such a car. The steel under-frame with wooden floor and siding is best suited to the needs of our railroads. With the adoption of this plan there will be a material change in the methods required for repairs. The steel frame is practically indestructible, and there is no limit yet put to its durability where it has been used abroad.

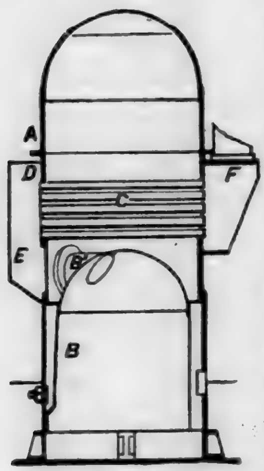


A FRENCH FAST PASSENGER BOAT.

In wooden cars the paper notes many improvements which have been made in methods of framing, trussing and bracing, in draw-gear and other points. The flat center-plate is now very generally used, and the use of oil on the center-plate is growing more general. Pressed steel and malleable iron are gradually replacing cast-iron for many parts of cars.

The rigid truck is now much more in favor than a few years ago, and many roads which for a time used the swing-bolster truck are returning to the rigid type. The use of iron and steel brake-beams is also growing more general.

The paper was illustrated by a number of drawings, including plans of the Lamont steel car, one of the latest of this class designed.



KIRKALDY'S UPRIGHT BOILER.

A New Upright Boiler.—The accompanying sketch shows a new form of vertical boiler, recently patented in England by W. Kirkaldy, of London. It is an upright return flue boiler. The products of combustion pass from the domed fire-box *B* by lateral flues *B*¹ to the external chamber *E*, from which they reach the smoke-box *F* by the tranverse smoke-tubes *C*. The flat tube-plates *D* are secured tangentially to the cylindrical shell *A*, and, along with the smoke-tubes *C*, may be taken away bodily by the removal of the central shell section.

Road Improvement in Illinois.—Much work is being done in a quiet way for the improvement of country roads in the State of Illinois. It is true that the wheelmen are at the bottom of it, but it is also true that the farmers of this State have become interested, and the promoters in Chicago are quite hopeful of success.

It is proposed to ask the Legislature to establish a board of road commissioners, who will be more than mere names, and who will take an active interest in their work. This board should have the power of making special assessments on counties and using the money to repair the roads of that county, or, if necessary, to build new roads when the county has, for the most part, only dirt roads within its boundaries. Through the missionary work of the wheelmen the farmers of Illinois are beginning to find out that an investment of $1 in good roads saves the waste of $3 involved in the possession of highways no better than the average country road of this State.—*Chicago Post.*

A French Passenger Steamer.—The illustration herewith, from *Le Yacht*, shows the packet boat *La Seine*, built by the Société des Forges et Chantiers de la Mediterranée for the line between Dieppe and Newhaven, across the English Channel.

La Seine is of steel, and is 262.4 ft. long, 29.5 ft. beam, 15.1 ft. deep and has a mean draft of 8.9 ft. There are two four-bladed screws, each 9 ft. in diameter; each is driven by a vertical, inverted triple-expansion engine, having cylinders 24.4 in., 35.8 in. and 55.1 in. in diameter by 25.6 in. stroke. There are six cylindrical boilers, built to work at 160 lbs. pressure; forced draft can be used.

On the trial trip the voyage across the Channel and return was made at an average speed of 20.9 knots an hour. With forced draft and with the engines making 206 revolutions a minute, a speed of 22 knots was reached; the engines developed 4,600 H.P. The contract required the boat to make the trip in 3½ hours, but the actual time was 3 hours 10 minutes.

An Old Passenger Car.—The Old Colony Railroad, of Massachusetts, has in its possession the body of an old passenger car built in the early days of railroading. It was modelled after the stage-coaches of those days, and carried on a four-wheel truck to which the draft appliances were attached. Mr. John Lightner, for many years Master Car-Builder of the Boston & Providence Railroad, who designed and built these cars, is still alive. Mr. J. N. Lauder, the Superintendent of Rolling Stock of the Old Colony, has arranged with Mr. Lightner to rebuild this car for exhibition at the World's Fair. The same road has also some old-style inside-connected locomotives, one of which it will perhaps exhibit.—*National Car and Locomotive Builder.*

An Old Heavy Rail.—In his recent report as Curator of the Section of Transportation of the National Museum in the Smithsonian Institution, Mr. J. Elfreth Watkins writes as follows: "During the year 1848 a very interesting experiment was tried by the Camden & Amboy Railroad. Arrangements were made with Cooper & Hewitt, at the Trenton Iron Works, to roll a 92-lb. rail, 7 in. high, with a base 4⅝ in. wide; 15 miles of the Camden & Amboy road were laid with this rail the following year. The Engineer of that company believed that he had at last solved the problem of track construction, inasmuch as this rail gave an admirable opportunity for a strong joint. By experience it was found that this rail was too rigid, and produced so much concussion by the train that the ends soon hammered out, and where the ballasting was imperfect great damage was caused to the rolling stock; consequently the rail was soon after taken up. Much of this old rail found its way to the cities, where it was bought by architects and contractors for building purposes. Among other places many of these rails were used for beams in the United States Mint in Philadelphia. The fact that this rail was rolled successfully resulted in the introduction of the 'I' beam for architectural purposes, Cooper & Hewitt having done a large business at the New Jersey Iron Works, at Trenton, in this line ever since that time. Fig. 47 (given herewith) is drawn from a section of this rail in the collection. It was laid between Bordentown and Burlington in 1849."

FIG. 47.—92-LB. RAIL, LAID IN 1849.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, APRIL, 1892.

THE National Electric Light Association ought to change its name by dropping the "Light," if the proceedings of its last meeting are an indication of the work done by its members. Comparatively little was said about the electric light; nearly all the papers read and nearly all the discussions having reference to the transmission of power by electricity and the use of electricity in operating railroads and machinery of various descriptions. With the rapid development of electrical science these applications are becoming of very much greater importance than the lighting, and electrical engineers are now and are likely to continue to be occupied more and more with these applications of power.

THE wooden vessels of the Navy are fast disappearing, and their final condemnation will be hastened by a provision in the Naval Appropriation Bill which reduces the limit of repairs which may be put on them from 20 to 10 per cent. of the original cost.

A special exception, however, is made in the case of the *Hartford* and the *Kearsarge*, and those two ships will be kept in commission in consideration of the notable services they have rendered in the past.

THE *Directory* of the American Steel & Iron Association reports that 52 new blast furnaces were built last year —1 for using anthracite coal, 16 for charcoal and 35 for coke or bituminous coal. There were 58 furnaces abandoned or torn down; but the reduction is apparent only, as the capacity of the new furnaces is considerably greater than that of the old ones, nearly all of those abandoned having been small furnaces. The addition to the rolling mill capacity was also considerable, 43 new mills having been built during the year and 28 given up. Here, as with the blast furnaces, the new mills are generally of larger capacity than the old ones abandoned.

SIX new Bessemer steel plants have been established during the year, making 46 plants of that kind now in the United States, with 95 converters. In addition to these there are 5 Clapp-Griffiths and 4 Robert-Bessemer steel plants, having together 15 converters. The making of open-hearth steel has also had a large growth, 17 new plants having been built, making 71 plants of this kind now in operation, with 5 new ones in the course of erection. The production of basic steel has made considerable progress, but has not yet risen to a position of importance. The crucible steel works about hold their own, and there are now 45 plants of this class in operation and 1 under construction.

IT has been supposed that the extending use of Bessemer was driving wrought iron out of the market; and some experts have even predicted that puddling would become a lost art. This does not appear to have been the case, however, for the Association reports 5,120 puddling furnaces in operation, an increase of 206 in three years. Accepting these figures, it can hardly be said that steel is replacing wrought iron. Perhaps it would be better to say that the increased demand for metal for general structural purposes is being met by steel rather than by iron. The rail business was not good last year; but the deficit in this direction seems to have been almost, if not quite, made up by this demand for steel for other purposes.

STATISTICS are exceedingly valuable; but as the careful student well knows, nothing can be more misleading or more provoking than statistics carelessly gathered and stated without proper order or method. Too much of this kind of work is done, and the time and effort spent in doing it is utterly wasted so far as any good result is concerned. A chaotic mass of figures may impress some persons with a sense of authority, but a very slight analysis will show of how little value it really is. It is very irritating to see such so-called statistics, when we know that the same work, or less, would have produced really valuable results.

In this connection it may be well to quote a brief paragraph from Professor Meitzen's "History and Theory of Statistics," probably the best and most thorough work on the subject: "The things to be included in the enumeration must correspond entirely with the preconceived notion of the unit of enumeration. Nothing contained in the aggregate which corresponds to this idea can be passed by unnoticed. This is the indispensable condition of the correct enumeration, and therefore of paramount importance as the basis of the entire process."

This paragraph deserves to be most carefully studied by all who have to gather and arrange statistics.

ENGLISH AND AMERICAN LOCOMOTIVES.

OUR esteemed contemporary, *The Engineer*, in its issues of February 26 and March 4, is making itself merry over the data which we published some months ago concerning the performance of American locomotives. As hilarity is such a rare privilege in technical journalism, our contemporary may be left undisturbed in its paroxysm of merriment for another month before serious reflection is imposed on it.

We confess to a little surprise, though, at the admission which our critic makes in saying that:

"All we have contended is that American locomotives are less economical machines than English engines; and we have carefully avoided the complications which crop up the moment we begin to deal with the prices of coal, oil and labor. . . . It is, we think, expedient therefore to confine our attention strictly to the narrower and more manageable proposition with which we started, and compare English and American locomotive per-

formance on the basis of fuel burned and weights hauled, and leave on one side the discussion of prices."

In other words, the proposition which locomotives will do the work that they are intended for at the least *total* cost! *The Engineer* will not discuss. The urgent question which is pressing itself on the attention of every railroad manager in this and other countries is, How can the expenses of operating their roads be reduced? Competition and declining rates are daily presenting their peremptory demands for economy. What class of locomotives will perform the required service at the lowest *total* cost is the importunate question which no railroad manager can escape; the answer to which is often one side of a dilemma, and declining dividends or bankruptcy the other. The narrower question as to which engines burn the least amount of fuel per train or per ton mile we confess seems hardly worthy of further discussion; and its answer with any obtainable data is probably not now susceptible of satisfactory proof; and only careful and impartial tests of locomotives made under exactly the same conditions would give conclusive evidence with reference thereto. The broader question as to which class of locomotives performs the service in which they are used at the least *total* cost is, as we have said, one which is forced upon the attention of every railroad manager in the world.

An international test of locomotives during the Columbian Exhibition at Chicago would be of very great interest to railroad men everywhere.

We—and we believe we can speak for many of our readers—continue to regret that *The Engineer* is not disposed to publish engravings of a representative English locomotive in sufficient detail to show the construction of all its parts, so as to make what may be called an anatomical comparison of each possible. We renew our offer to furnish our contemporary either drawings or electrotypes of engravings—the size of the latter to be adapted to our pages and those of *The Engineer*—of a representative American express engine in exchange for similar illustrations of an English locomotive of corresponding class and capacity.

HOW DOES A LOCOMOTIVE PULL ITSELF?

THIS problem is a very old one, and was discussed at considerable length some time during the fifties, in Zerah Colburn's *Railroad Advocate*, and probably puzzled a good many people before that time. Nevertheless, it comes up in perennial periods, and seems always to be a novel subject to a new class of readers. Like the preachers, an editor must occasionally turn his barrel upside down and repeat his homilies to those who are happily younger than he is, but unhappily less experienced.

The discussion of this subject has just broken out afresh in the correspondence column of the London *Engineer*, and the usual amount of misapprehension of the subject has shown itself in letters which have been published. It has, therefore, seemed that a little fresh elucidation of the subject might not be unwelcome to some of our readers. Those who have crossed over the half century divide which separates the optimistic from the pessimistic periods of life, and whose capillatures show the effects of early autumn frosts, need not read what follows, as it is not likely to contain anything which will be new to them.

In this, as in many other discussions, the first and a serious stumbling block arises from the ambiguous meaning of a term. The problem, in fact, may, to some extent, be stated by the question, Where is the *fulcrum* of a locomotive driving-wheel? The definition of the word *fulcrum* given in Webster's Dictionary is "that by which a lever is sustained, or the point about which it turns in lifting or moving a body." Now if the whole of a lever moves while it is in action, it is often a matter of very great doubt where it is sustained. Take the case of what is called the "floating lever" of a car-brake. Here the power is applied usually between its two ends, and the whole lever is in motion. Either end may then be regarded as the fulcrum.

In books on mechanics it is usual to classify levers into three "orders." Thus, in Deschanel's "Natural Philosophy" it is said that "in levers of the first order, fig. 1, the fulcrum is between the power and the weight. In those of the second order, fig. 2, the weight is between the power and the fulcrum. In those of the third order the power is between the weight and the fulcrum." Now suppose that each of these "orders" of levers was a brake lever such as has been described, then whether the fulcrum is in the middle or at the end in the first and second orders would be altogether uncertain, and it would be equally so whether it was at one end or at the other in a lever of the third order. It is desirable, therefore, to ignore altogether the word *fulcrum*, and if we consider only the forces which act on a lever, it will make our explanation much more clear, and an understanding of the action of levers easier than it will be if we try to determine which is the fulcrum.

From fig. 1 it will be noticed that the power P and the weight W both exert a force downward, and if the lever rested on a support, C, which consisted of, say, a sharp

Fig. 1.
LEVER OF THE FIRST ORDER.

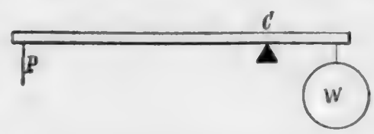
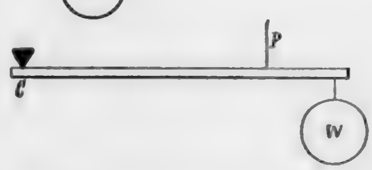


Fig. 2.
LEVER OF THE SECOND ORDER.

Fig. 3.
LEVER OF THE THIRD ORDER.



metal edge, it would make more or less of an indentation on the under side of the lever, showing that at that point there was a force, or reaction, if we choose to call it so, which is exerted upward in relation to the lever. It will be noticed that the forces at each end act in one and the same direction, and that which is exerted in the middle acts in the opposite direction. Now this is true of each of the other orders of levers. In fig. 2 P and C act upward and W downward, and in fig. 3 C and W act downward and P upward. Without going into a full elucidation of the elementary principles of the lever, it may be stated generally that the sum of the two forces acting on the ends is always equal to that acting in the middle and in the opposite direction. Thus, in fig. 1, $P + W = C$, in fig. 2, $C + P = W$, and in fig. 3, $C + W = P$. If, then, instead of designating these forces as the *power*, the *weight*, and the *force acting on the fulcrum*, we call the greater of the

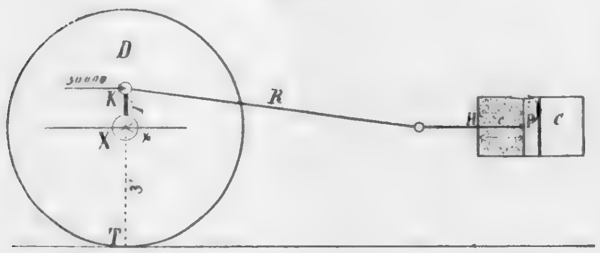
two forces which acts on the short end of the lever, and in the same direction as that acting on the other end, the *major force*, and the smaller force which acts on the long end of the lever the *minor force*, and that which acts on the middle of the lever and in the opposite direction to the end forces, the *counter force*, we will do much to clear up the ambiguity with which the whole subject is sometimes surrounded. In fig. 1, *P* is the *minor force*, *W* the *major force* and *C* the *counter force;* in fig. 2, *C* and *P* are the *major* and *minor* respectively, and *W* the *counter force*, and in fig. 3, *W* and *C* are the *major* and *minor* and *P* the *counter forces*. Now it is universally true that if the major and minor forces are added together, their sum will always be equal to the counter force, and, as stated, that they always act in opposite directions.

With this terminology it will be seen that there really is no difference in the principle of action of the levers of the different orders. In all of them the *major* and *minor* forces act on the ends of the lever and the *counter force* on the middle and in the opposite direction. The two forces acting on the ends may be exerted in any direction—that is, either up or down or sidewise; but, in any event, the counter force always acts in opposition to them. In figs. 1 and 2 *P* and *W* and *C* and *W* act downward, whereas in fig. 2 *C* and *P* act upward.

Having this clearly in our minds, we are in better position to understand how a locomotive pulls itself than we would be if we tried to determine which is the fulcrum in different positions of the cranks and pistons.

Supposing now that in fig. 4, *D* represents the driving-wheel of a locomotive, *C* the cylinder, *P* the piston, *R* the

Fig. 4.



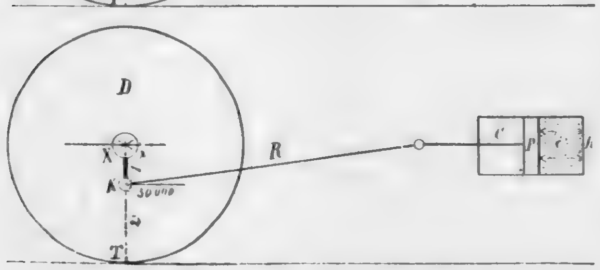


Fig. 5.

connecting-rod, *K* the crank-pin, and *X* the axle. It will be supposed, further, that the crank-pin is above the axle, as shown at *K*, and that the steam is acting in the back end *c* of the cylinder and is exerting a total pressure on the piston of 30,000 lbs., as indicated by the darts at *c*. Leaving out of account the effect of the angularity of the connecting-rod, this pressure is transmitted to the crank-pin, and is exerted in a forward direction, as indicated by the dart at *K*. It then acts on the spokes of the wheel, which may be regarded as a lever, *K X T*, *K* being the major force. It will be supposed that the driving-wheel is 6 ft. in diameter, and the stroke of the piston is 2 ft. The lever *K X T* will then be 4 ft. long, the short arm *K X* being 1 ft. and the long arm *X T* 3 ft. long; consequently, the counter force exerted at *X* will be equal to $30{,}000 \times 4 \div 3 =$ 40,000 lbs. This will tend to push the engine forward, or in the direction of the dart *X*. But while the steam is acting on the piston it also exerts an equal pressure on the back cylinder-head *H*, as indicated by the darts. The cylinder being fastened to the frame, this pressure is transmitted by it to the axle *X*, and tends to push it backward, as indicated by the dart *x* with a force equal to 30,000 lbs. Consequently there are two forces acting on the axle, one tending to push it forward with a force of 40,000 lbs. and the other urging it backward with a pressure of 30,000 lbs. The net result is a forward pressure of 10,000 lbs., which is communicated to the frame of the engine, and represents the tractive power of the cylinder.

When the crank-pin is below the axle, as shown in fig. 5, and steam in the front end of *c* of the cylinder is acting on the piston, then a backward force is transmitted to the crank-pin, and acts on a lever, *X K T*, as indicated by the dart at *K*. This is the counter force acting on a lever whose long arm *K T* is 2 ft. and whose short arm *X K* is 1 ft. long. Consequently the force exerted at *x* tending to push the engine backward is equal to $30{,}000 \times 2 \div 3 = 20{,}000$ lbs. At the same time, the steam exerts a pressure of 30,000 lbs. on the front cylinder-head *h* which is transmitted to the frames and to the axle, and is indicated by the dart *X*. Consequently there are two forces acting on the axle—one of 30,000 lbs. tending to push it forward, and another of 20,000 lbs. tending to push it backward, the net result being a force of 10,000 lbs. pushing the engine forward. The length of the darts *X* and *x* in the two figures are drawn to a scale, and their lengths represent the magnitude of the forces acting on the axle.

From this explanation it will be seen that it is not a matter of the slightest importance whether the point of contact with the rail or the axle is regarded as the fulcrum. All we need do to get a clear idea of the action of the forces is to understand their effect when applied to the wheels, as has been described. If any reader has any difficulty in comprehending how the steam acts, he may imagine that a small boy, endowed with a superhuman capacity of exerting a force of 30,000 lbs., is enclosed in the back and front ends of the cylinder respectively of figs. 4 and 5, and that he is pushing against the piston with his hands and against the cylinder head with his feet, and he—the reader, and perhaps the boy—will then have a clear idea of how the steam acts.

It is sometimes thought that a locomotive will start a heavier load when the crank-pin of one cylinder is above the axle than it will when it is below, because it is said the steam pressure is then acting on a longer lever in the wheel. This, it will be seen, is a mistake. A locomotive will exert its maximum tractive effort when the two cranks stand at angles of 45° with a vertical or a horizontal line and are behind the axle. The tractive force which can then be exerted with any pressure of steam in the cylinder will be considerably greater than it is when the cranks stand at the same angle and are both in front of the axle. This is due not to any difference in leverage, but to the influence of the angularity of the connecting rods. When both cranks are above or below the axles and stand at angles of 45° to a horizontal or vertical line, the tractive force which will be exerted with a given steam pressure will be the same.

WIRE-WOUND GUNS.

A TRIAL of the Brown segmental wire-wound system was had at Birdsboro, Pa., February 26, and if certain press reports of this experiment are accepted, one might believe that the problem of gun construction had been settled for good and all.

Following the specifications of the letters patent in this case, granted in 1889, the Brown gun may be described as made up of a number of longitudinal sections or segments of a circle, fitted together laterally, preferably with tongue and groove, around which wire is wound from breech to muzzle, and over this is a thin outer shell of steel for the protection of the wire. The joints, or meeting edges of the segments, may run straight from breech to muzzle, or be spiral, following the grooves of the rifling. No special method of securing the breech-block is provided for.

The experiment referred to was made with a cylinder, representing a section of the 5-in. Brown gun, 16 in. in length, with an internal diameter of 5 in. and an external diameter of 15 in. Twelve segments, 3 in. in thickness, and 2 in. of wire in 31 layers, made up the 5-in. thickness of metal around the bore. The two ends of this hollow cylinder were closed with plugs; the lower one—the cylinder was set on end for firing—had two pressure gauges secured to it, and the upper one was a vent 2 in. in diameter to afford access to the charge and to allow for the escape of gas. One preliminary and four other charges were fired, of from 2½ to 3½ lbs. of Dupont powder, with recorded mean pressures of from 35,200 to 53,850 foot-pounds.

Granting that the recorded pressures were correct, it is not easy to understand the value of this experiment in determining the merits of this system of gun construction. While the experiment clearly shows that a number of short, carefully-made staves of metal supported at both ends and wound with steel wire of high quality, will withstand great pressure without rupture, it in no wise shows that a 35-caliber finished gun, constructed upon the same lines, would withstand anything like the strain recorded in the experiment under consideration.

It is hardly necessary to recall the fact that since the first experiments with wire-wound guns, nearly forty years ago, down to the present time, it has not been a want of strength to resist transverse rupture, but longitudinal weakness that has stood in the way of success of the wire-wound gun. The failures of Longridge, Schultz, and others abroad, and of Woodbridge in this country, all go to show how difficult it is to prevent such guns from pulling apart in the direction of their length, while, given good materials, there is hardly a practicable limit to the strength that can be given to such guns to resist transverse strain alone.

If one were to venture upon a criticism of the system in advance of its thorough test, it would be to point out what seems to be two grave defects: (1) the seating of the breech-block, not as in the ordinary built-up gun, either in the thick, solid inner tube that forms the bore of the gun, as in the French construction; or in a heavy, substantial jacket connected directly with the trunnions, as in our own—but in the rear ends of a dozen, more or less, of individual staves or segments of metal, and (2) in the presence of a greater or less number of joints along the interior of the bore. When one remembers the tremendous scoring effect of powder gases of high temperature and tension upon the bore of a gun, and their insinuating quality, one may well apprehend serious consequences from this method of construction.

The press reports speak of a thin inner tube or lining as entering into the construction of the gun, but no mention is made of it in the patent specifications before us. The unlucky experience of the English with "liners" for their heavy guns does not lead one to put much confidence in this device.

Extended criticism of this and of other systems of wire-wound gun construction may well be postponed until the guns now being built are brought to the trial butts. A 5-in. Brown, a 10-in. Woodbridge, and a 10-in. Ordnance gun are likely to come to trial during the present year. The success that has recently been met with in the English and Russian gun factories in the fabrication of wire-wound guns, prepares one to believe that the coming gun may be one of this character.

THE MASSACHUSETTS COMMISSION REPORT.

THE Massachusetts Railroad Commissioners' report, as usual, considers a variety of important topics. The first of these is the question of harmony in railroad legislation among the different States; and here reference is made to the action taken to prepare a general compilation of the railroad laws of several New England States and of New York in order to ascertain the variation in the laws of those adjoining States and the measures which may be taken to bring them more into accordance with each other.

A topic of somewhat similar nature is the question of safety appliances, the extent to which laws relating to them may be maae to harmonize with each other, and the degree to which federal legislation might extend. Under this head some attention is paid to the action taken by the Conference of Railroad Commissioners which was held in Washington last year.

In matters more peculiar to the State the Commissioners note a considerable advance in the adoption of steam-heating systems. All the leading railroads of the State now have a large number of cars fitted for heating by steam from the locomotive. The reports show that the total number of cars fitted in this way on Massachusetts railroads is now 2,291, or 73 per cent. of the entire passenger equipment, being an increase of 30 per cent. during the year. On several of the roads all the passenger trains will be next winter run without fire in any of the cars.

Some progress has been made in doing away with grade crossings. Only a few new ones have been authorized during the year, and those at unimportant points, where the highway traffic is very small, while proceedings have been taken in 93 cases for the abolition of such crossings, and in 20 cases work is actually in progress. In this connection the Commissioners call attention to the special danger involved in all crossings of railroad tracks by street railroads, and to the apparent increase of this danger where electrical cars are used.

Another subject nearly related to this is the somewhat difficult and intricate question of the grade crossings of the various lines entering Boston from the north and northeast. The present crossings of the Fitchburg, the Boston & Lowell, the Boston & Maine, and the Eastern tracks are a source of serious delay and danger, and the Board has had a careful examination of the question made and a plan submitted by their engineer for a rearrangement of the tracks and stations on these roads, which will not only do away with the railroad crossings, but will also prevent much of the obstruction to street traffic resulting from the present arrangement.

As to general statistics the railroad statements for the year show that there was 3,217 miles of road belonging to the companies which make returns to the Board. The business of

these roads shows a fair amount of increase, but this was more than balanced by the increase in working expenses, leaving a small decrease in net earnings. Both passenger and freight mileage show an increase, while the average earnings per unit of traffic remain about stationary. The increase in rolling stock was not large, probably not much exceeding that required by the gradual growth of the business. About the usual amount of improvement is shown, and the additional mileage laid with steel rails was about 10 per cent. of the whole.

Considerable space is given to the investigation of the Zone Tariff System, a work imposed upon the Board by a resolution of the Legislature last year. The working of this system in Hungary and Austria has attracted much attention in Europe, and to some extent in this country also. The Board presents statements which have evidently been carefully considered, as well as a comparison of the conditions existing in the countries named, and in Massachusetts, and comes to the final conclusion that the system presents no advantages which would warrant its present introduction in this country. The real advantage gained in Hungary was due to the great reduction of rates much more than to the simplification of the ticket system, and the adoption of the Zone system here would probably prove a hardship in many cases, besides making a much less equitable arrangement than the present system of basing fares on mileage.

NEW PUBLICATIONS.

VOLUME I: IRRIGATION CANALS AND OTHER IRRIGATION WORKS.

VOLUME II: THE FLOW OF WATER IN IRRIGATION CANALS, DITCHES, FLUMES, PIPES, ETC. By P. J. Flynn, C.E. Two volumes bound in one; 711 pages, 92 tables, 211 illustrations. Published by the Author, Los Angeles, Cal.; price, $8.

In these two volumes Mr. Flynn has undertaken to fill a gap in professional literature by a work for which he is peculiarly fitted by training and experience. Irrigation on a large scale is comparatively new in this country, and what has heretofore been written on the subject is of a very fragmentary nature, and is scattered through numerous reports, papers, and society proceedings, where it is by no means easy to find it; so that those engineers who have works of irrigation under their charge have found it difficult or impossible to avail themselves of the results of past experience.

Volume I of Mr. Flynn's book is devoted to Irrigation Canals and Irrigation Works generally, and here he has presented in a compact form a great body of information on past practice, not only in this country, but also in Spain, India, and other countries where lands have been irrigated for centuries. He has evidently searched out and obtained information from all available sources; but the book is not by any means a mere compilation, containing a great deal of original matter. The book treats not only of canals, but also of various other constructions—dams, reservoirs, weirs, and the like—and of systems of distributing and using the water after it has been carried to the points where it is needed. This volume has many illustrations showing methods of construction and notable examples of work.

The discussion of methods of actual irrigation—that is, the distribution of water to the land, will be of especial help to engineers. It is in this point that experience is most lacking in this country, and it is in these methods that waste and loss is most likely to occur. This discussion and the comparison of various plans is very full, and occupies a considerable part of the volume. Where irrigation is most needed water is usually scarce, and it is of importance that the available supply should be used to the best advantage, and that all waste should be prevented.

Volume II is devoted to discussing the flow of water in canals and in open and closed channels generally. Here Mr. Flynn has adopted the formulas of Kütter, D'Arcy, and Bazin, and treats of their application, which he has simplified by the preparation of numerous tables. Some of these have already been tested by use; and there can be no doubt that they will prove a very great convenience to engineers. They cover a great variety of channels of various forms, both open and closed, of various sizes and sections, and with different kinds of surfaces, covering about all the cases likely to be encountered by an engineer in actual practice.

Some space is also given to a special discussion of the flow of water in sewers, pipes, and closed conduits, and in this comparison is made of almost all the formulas which have been in use or proposed. The results appear in the form of numerous tables, simplifying very much the application of the formulas approved and adopted. This part of the book will be of value to engineers engaged in any kind of hydraulic work.

The whole book constitutes an exhaustive and valuable treatise, and the author has produced a work which ought to be thoroughly appreciated by engineers, and which is evidently the result of long study and experience and of much labor.

The book is well printed in clear type, and is an excellent specimen of book-making. One point which deserves commendation is the use of large type for the tables, avoiding the appearance of crowding, and the fatigue to the eyes which too often results from reading tabular work. A very full index, which is appended, leaves little to be desired in the book.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. *Vol. XII., XXIId Meeting, Richmond, Va., Nov., 1890. XXIIId Meeting, Providence, R. I., June, 1891.* (New York. Published by the Society.)

This volume of 1,074 pages gives very convincing evidence of the prosperity of the Society. It contains 47 different papers—on a range of subjects whose scope is too wide to describe in a notice of this kind—besides addresses and discussions on other topics pertaining to the objects of the Society. In a preliminary note it is also said that the increasing bulk of the annual volume of *Transactions* has induced the Publication Committee to discontinue the insertion of the full list of members among the preliminary matters therein. The summary of membership shows that the total number is 1,344, which with the "Proceedings" is indisputable evidence that the Society is prospering. Of course, this prosperity is not correctly measured by the bulk alone of its *Transactions* or the number of its members, but these show that the Society is in a position in which it can safely exercise the privilege of exclusion of papers from its publication and candidates from its roll. The degree to which this privilege is wisely exercised will in future be indicative of the real prosperity and usefulness of the organization.

The range of subjects discussed in the volume before us is a very wide one, and shows how the profession of the mechanical engineer is extending. There are papers on Cable Road Construction; Chimney Draft; Properties of Ammonia; Properties of Sulphur Dioxide; Efficiency of Vapor Engines; Heat Transmission; Regulation of Injection Water to Condensers; Flexible Tubing; Hydraulic Traveling Cranes; Lubricants; Rope Driving; Accident Providing Devices; A Process of Cutting the Teeth of Spur Wheels; Single-Acting Compound Engine; Hydraulic Hoisting Plant; Latent Heat of Ammonia; A 75-Ton Refrigerating Machine; Experiments with Lubricants; An Engineering Problem at Richmond; Steam Jackets; Duty Trials of Pumping Engines; Rope Haulage; Triple-Expansion Engine; Blast Furnace Blowing Engine; Belt Dynamometer; Subdivision of an Index Wheel; Belt Testing Machine; Steel Castings; The Perfect Screw Problem; Steam Engine Efficiencies; Hirn's Analysis; Premium Plan of Paying for Labor; Experiments with a Screw Bolt; Calorimeters; Steam Jacket; Steam Reaction Wheel; Jib Propul-

sion; Flexure of Thin Elastic Rings; Mechanical Stoker; Economy of Compound and Single Cylinder Corliss Engine; Manganese Steel; Performance of a Worthington Pumping Engine; Heat Transmission through Plates Pickled in Nitric Acid, and Topical Discussions.

BOILER TESTS. *Embracing the Results of One Hundred and Thirty-seven Evaporative Tests made on Seventy-one Boilers, Conducted by the Author.* By George H. Barrus, S.B. Published by the Author, Boston.

The title of this book is sufficiently explanatory to give an idea of its scope; and in the introduction the Author says that its chief object is "to give a review of the various results and a consideration of the general subject of economy in the generation of steam, as revealed by the tests."

This the Author has done in a way which should earn for him the gratitude of the whole profession of mechanical engineers.

After describing the methods of conducting the tests, he makes a comparison of boilers which produce saturated steam with those which produce superheated steam. The first class, he says, are, as a rule, of the horizontal tubular type, and the second class of the vertical type. It is then shown that although the latter, owing to insufficient heating surface, will not evaporate as much water per pound of coal as boilers of the horizontal tubular type do, yet, owing to the greater value of superheated steam, the economy of the vertical type is often nearly or quite equal to that of horizontal boilers.

Proceeding to the consideration of the "General Conditions which Secure Economy," it is shown that the highest results are produced where the temperature of the escaping gases is the least. In other words, the greater the amount of heat which is absorbed by the heating surfaces and the water in the boiler before the heat escapes up the chimney, the greater the economy, which ought to be very obvious, but which is often overlooked. The temperature of the escaping gases which will produce the best results the Author concludes is about 375° for anthracite and 415° for Cumberland (bituminous) coal.

The relation between the heating surface and the grate area which will produce the highest efficiency is also considered. The conclusion is that for anthracite coal it should be in the proportion of 36 to 1, and that either more or less produces a loss, when the rate of combustion does not exceed 12 lbs. of fuel per square foot of grate per hour. For bituminous coal the ratio should be from 45 or 50 to 1, and the conclusion is drawn that a "much larger amount of heating surface is required for obtaining the full efficiency of bituminous coal than for boilers using anthracite coal."

Another interesting conclusion deduced from the experiments is "that a certain minimum amount of tube opening is required for efficient work." The highest efficiency, he concludes, with anthracite coal is obtained when the tube opening is from one-ninth to one-tenth of the grate surface. For bituminous coal he concludes that the area of the tube opening should be from one-sixth to one-seventh of the grate surface.

A comparison is then made of the economy of different kinds of boilers, which is very interesting; but there is room here to give only the writer's conclusions. The form of horizontal boiler, he says, which with suitable proportions and operation can be depended upon to give the highest evaporation is the common horizontal return tubular boiler so widely used in New England factories.

Of the plain cylinder boiler it is said that it is of evident inferiority as an economical generator of steam. The vertical tubular boiler, when properly designed, the Author concludes, is at least equal to the horizontal boiler in economy.

The three cast-iron sectional boilers which were tested gave comparatively poor results; but this is attributed in a great measure to unfavorable conditions and to insufficient heating surface to grate area.

Of nine water-tube boilers which were tested, only one reached the standard laid down for economy. This one had a sufficient ratio of heating surface to grate area. All the others had a deficiency in the quantity of heating surface, and consequently a high temperature in the flue. "On the whole," the Author says, "the water-tube boilers may be considered to be equal in economy to the tubular boilers under the conditions of comparison determined upon—that is, when the conditions are favorable to economy."

"The general conclusion," he says, "to be drawn from all these comparisons is that the economy with which different types of boilers operate depends much more upon their proportions and the conditions under which they work than upon their type; and, moreover, that when these proportions are suitably carried out, and when conditions are favorable, the various types of boilers give substantially the same economic result."

A separate section is devoted to a comparison of the value of different kinds of coal, the general results of which are given in the following table:

NAME OF COAL.	Lbs. of water evaporated from and at 212 degrees per lb. of dry coal.
Anthracite, Broken	9.79
Cumberland, Bituminous	11.04
Anthracite, Chestnut	9.40
Anthracite, Pea	8.86
Two parts Pea and Dust and one part Cumberland	9.38
" " " " " " " " Culm	9.01
Nova Scotia Culm	8.42

Some tests were also made to determine the value of petroleum as a fuel, the conclusions from which the Author sums up as follows: "This means, in round numbers, that the price of oil must be less than one dollar per barrel, delivered at the boiler, in order that the cost of fuel and labor for a 1,000 H.P. plant shall be equal to that which obtains when Cumberland coal is used at $4.56 per ton."

In making experiments, Mr. Barrus made some observations on the effect which the form of setting has when the boiler is externally fired. His conclusion is that the matter is of comparatively little importance, and that the plan to be followed is the one which will secure the simplest and at the same time the most convenient arrangement.

On the effect of admitting air into the furnace above the fire, he concludes that a considerable advantage—from 6 to 8 per cent.—attends the admission of air above the fuel when bituminous coal is employed, the amount of gain depending somewhat upon the method employed, but that little or no benefit is derived when anthracite coal is burned.

On the effect of feed-water heaters placed in the flues he shows that in cases of reasonably good practice the evaporation of water per pound of coal was increased very nearly 10 per cent. by their use. For a plant of 1,000 H.P. the Author estimates a saving from the use of a feed-water heater, with coal costing $4.56 per ton, at $1,759 per year. The cost of a heater with complete equipment of setting and appurtenances is from $7,000 to $8,000. The saving would therefore pay a yearly return of from 20 to 25 per cent. on the additional investment. Obviously, if coal cost only half as much, the saving by the feed-water heater would be only from 10 to 12½ per cent. on its cost, which is not more than a prudent business man would allow annually for interest, repairs, and deterioration, so that the conclusion would be that feed-water heaters are economical when coal costs more than $2.28 per ton, but are not if it costs less.

The second part of the volume before us gives detailed reports of the tests and engravings of various boilers tested by the

Author. The reasoning, inferences and conclusions drawn from these tests are given in the first part, from which we have made liberal quotations. In this way the whole subject is admirably presented, and in such a form as to economize the reader's time and attention as much as possible, the importance of which is often lost sight of by those who write for busy men's reading. The book contains about 70 diagramatic engravings of boilers and their settings.

In the appendix descriptions are also given of the Author's coal and steam calorimeters, with a report on the heating power of various coals.

Altogether the book is an admirable one, and cannot be too highly commended to all steam users and engineers interested in boiler use and construction. An especial feature worthy of praise is the absence of mathematical gymnastics, with which so many writers on technical subjects now befog the subjects which they attempt to elucidate.

The Transition Curve Field Book and General Tables. By Conway R. Howard, C.E. John Wiley & Sons, New York.

The use of transition curves and their value are well known to engineers in railroad practice, and a field-book specially devoted to the subject is of service in a great many cases. The object of the present one is, perhaps, best explained in the words of the author:

The aim of this Field-book is to furnish plain, practical rules and examples for guidance in adjusting and locating a curve, nearly identical with the cubic parabola as a transition curve in connecting circular curves with tangents.

In the investigation of the principles upon which the rules are based, it will be seen that with data consisting in great part of familiar approximations used in circular-curve location, and with no mathematics beyond a little algebra and trigonometry, practically exact results are reached in regard to laws of the transition curve and its relation to circular curves.

By means of transition curves of less than 15° of central angle, tangents can be connected with all circular curves used on railroads, their combined location presenting little if any more difficulty than ordinary circular-curve location.

Mr. Howard presents a general statement, followed by a number of cases of frequent occurrence in location. This is supplemented by the tables which the engineer is likely to need in his field work. The whole makes a practical and convenient handbook and an excellent companion for the engineer.

TRADE CATALOGUES.

Catalogue of the Niles Tool Works, Manufacturers of Iron and Steel Working Machinery, Railroad, Car, Boiler and Machine Shop Equipments. Hamilton, O., 1891.

This very handsomely printed and illustrated catalogue describes a large number of machine tools, including lathes of various kinds, planers, shapers, slotting machines, drill-presses, boring machines, etc. The quality of the tools made by these works is well known; but perhaps the variety will be better appreciated after a study of this catalogue, from which a complete equipment for a large shop can be readily selected.

The Meneely Bearing Company: Patented Tubular Roller Journal Bearings for Railroad Cars. Third Edition, 1892. *West Troy, N. Y.*

This pamphlet gives an illustrated description of the roller bearings made under the Meneely patent, with some statements of the experience had with them in actual service. This has certainly shown a remarkable degree of economy, with experience extending over a considerable time.

What Visitors Will be Shown at the World's Fair by Merchant & Company. Philadelphia.

This is a very amusing catalogue of exhibits, showing the supposed adventures of the representatives of a number of different nations at the World's Fair, while engaged in viewing the superlative exhibit of metals made by Merchant & Company, and that of the contrary class by their competitors. It should be seen to be appreciated.

The MacKnight Flintic Stone Company, New York. Illustrated Catalogue.

This catalogue shows a number of applications of the artificial stone made by the Company in pavements, sidewalks, fireproof roofs and floors, stables and machinery beds. It contains a description of the methods of manufacture and some other interesting matter. Like all engineers of experience, the managers of this Company evidently recognize the value of a good foundation for a roadway.

The Egan Company, in Cincinnati, O., has issued a large poster for distribution in South American countries, having a view of their shops and small illustrations of a large number of woodworking tools made there. A single glance at this is sufficient to show the extent of the Company's business and the extraordinary variety of tools which it is ready to supply.

The Lukenheimer Brass Manufacturing Company, of Cincinnati, O., have gotten out a unique calendar for 1892. It is on a card a little larger than the new postal card, and has stamped on it an excellent perspective view of the "Handy" gate valve which is made by the Company. The valve proper is in sight, and on the face of it is the invitation, "Investigate the handy;" by moving a small paper lever the valve is opened, and one reads the prophecy, "the coming gate valve."

CURRENT READING.

A new series of articles on the Poor of Great Cities is begun in Scribner's Magazine for April. In the same number the new Gold Fields of South Africa are described, and there are illustrated articles on the New Parks of New York City and on Historic Moments. The number is one of unusual interest.

The March number of Outing describes the organization of the Connecticut National Guard, and gives some excellent descriptions of the Pacific islands. The illustrations include some striking reproductions of instantaneous photographs.

The Overland Monthly for April has an unusual number of illustrated articles. These include one by Professor Holden, of the Lick Observatory; one on the Water Front of San Francisco, and another with a series of Indian pictures of much interest. Besides these there is the usual variety of stories and sketches, making an exceedingly readable number.

A new edition of the standard Treatise on Hydraulics, by Professor Mansfield Merriman, is now in preparation by Messrs. John Wiley & Sons, New York. The same firm have also in press a Text-book on Retaining Walls and Masonry Dams, by Professor Merriman.

In the Eclectic Magazine for March there is the usual selection of articles from English magazines, covering a wide range of subjects. Two of the more notable are M. Flammarion's on Inter-astral Communication, from the *New Review*, and Professor Crookes' on Some Possibilities of Electricity, from the *Fortnightly Review*.

The April number of the Popular Science Monthly continues Mr. Carroll D. Wright's Lessons from the Census by a valuable paper on Rapid Transit in Cities. Professor Jastrow has a study of Involuntary Movements, and the Great Earthquake of Port Royal is described by Colonel A. B. Ellis. There are several other papers which deserve a careful reading.

The Journal of the United States Artillery is a new periodical issued from the Artillery School at Fort Monroe. The first number has several papers of much technical value, and the editors deserve credit for its excellent appearance.

In recent numbers of HARPER'S WEEKLY there have been several articles of notable excellence. These include one on New Approaches to New York, describing the various plans for tunnels and bridges proposed for the Hudson and East rivers; one on the Wire-wound Gun, and one on the Movement for Better Roads.

Few of the magazines maintain a higher standard than the ARENA; the April number is a marked instance of this, and shows that the advanced position it has taken as an exponent of independent thought is well maintained.

Messrs. Richard H. and William H. Edmonds have retired from the management of the MANUFACTURERS' RECORD of Baltimore, which will hereafter be conducted by Messrs. Walter H. Page, E. H. Sanborn and T. P. Grasty. The RECORD has been a remarkably successful paper, and has done much good work in assisting the industrial development of the South.

The contents of the ENGINEERING MAGAZINE for March include articles on the Peary Expedition; What an Architect does for his Money; the Telephone Industry; the Manufacture of Ice; Dangers from Tall Office Buildings; Purification of Water, and several others by well-known engineers. It has also the fourth of Dr. Coleman Seller's papers on American Supremacy in Mechanics.

The March number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE is full of short articles on geographical topics, and is quite as bright as usual. This magazine always has something well worth reading.

In HARPER'S MAGAZINE for April Mr. Julian Ralph's papers on the Great Northwest are continued by one on Lake Superior, and the same writer discusses Western Methods of City Management. A paper on the Ancient Lake Region of America deserves note, and there are several very handsomely illustrated articles.

A new venture in the engineering field is CASSIER'S MAGAZINE, the February number of which has some very good illustrated articles. The subjects treated include Automatic Sprinklers; Corliss Valves; the Injector; the Forging Press; the Production of Aluminum; Rotary Engines; the Band Saw Mill, and several minor topics. The magazine is handsomely printed and the illustrations very good.

BOOKS RECEIVED.

Annual Report of the Chief of Engineers, United States Army, to the Secretary of War for the Year 1891. Brigadier-General Thomas L. Casey, Chief of Engineers. In six parts. Government Printing Office, Washington.

Geological Survey of Missouri: A Preliminary Report on the Coal Deposits of Missouri. Arthur Winslow, State Geologist. With 131 maps and illustrations. State Geological Survey, Jefferson City, Mo. This very valuable report is an evidence of the careful and thorough work which is now being carried out in Missouri.

Practical Carriage Building: Comprising Short Practical Articles on Carriage and Wagon Building, etc. Volume I. Compiled by M. T. Richardson, Editor of the *Blacksmith & Wheelwright.* The M. T. Richardson Company, New York; price, $1. This is a very useful and practical hand-book for carriage builders, containing much information which must be useful to them, and indeed to all wood-workers.

The Metal Worker Essays on House Heating by Steam, Hot Water and Hot Air. Arranged for publication by A. O. Kittridge, Editor. David Williams, New York. This is a reprint of several essays which appeared in the *Metal Worker,* and which were written in response to an offer of prizes for the best articles on the subject.

Lake Superior Iron Ore Production for the Past 36 *Years.* The *Iron Trade Review,* Cleveland, O.

Technical Conditions for the Preparation and Testing of Portland Cement in Russia. By Professor N. Belelubski. W. F. Häcker, Riga.

Timber Physics: Part I, Preliminary Report. Compiled by B. E. Fernow, Chief of the Forestry Division, Department of Agriculture.

Mineral Products of the United States, Calendar Years 1880 *to* 1890. Department of the Interior, United States Geological Survey; Major J. W. Powell, Director. This large table, prepared by Professor David T. Day, Chief of the Bureau of Mining Statistics, is exceedingly convenient for reference, giving the figures in a condensed form.

Census of Canada, 1891. *Bulletin No.* 4: *Population of the Province of Quebec.* Department of Agriculture, Ottawa.

Proceedings of the Ninth Annual Convention of the Roadmasters' Association of America; held in Minneapolis, Minn., September 8, 9 *and* 10, 1891. Published by the Association; J. H. K. Burgwyn, Secretary, Grand Rapids, Michigan.

Annual Report and Statements of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce and Navigation, Immigration and Tonnage of the United States, for the Yead ending June 30, 1891. S. G. Brock, Chief of Bureau. Washington; Government Printing Office.

Winnipeg, the Heart City of North America: Illustrated. Winnipeg, Manitoba; the Stovel Company.

Twentieth Annual Report of the Superintendent of Water Works, Bay City, Mich. E. L. Dunbar Superintendent. Bay City, Mich.; issued by the City.

Reports of the Consuls of the United States to the Department of State: No. 134, *November,* 1891; *No.* 135, *December,* 1891; *No.* 136, *January,* 1892. Washington; Government Printing Office.

India Rubber. Special Reports from Consuls of the United States in Answer to a Circular from the Department of State. Washington; Government Printing Office.

Annual Report of the Massachusetts State Board of Arbitration for the Year 1891. Boston; State Printers.

A LOCOMOTIVE PROBLEM.

A WRITER in *The Engineer* propounds the following interesting problem, which is submitted to our readers for solution:

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

SOME CURRENT NOTES.

THE Lehigh Valley Railroad is making some tests of a two-cylinder compound engine of the type designed by Mr. F. W. Dean, of Boston. The engine is of the consolidation pattern, has eight 50-in. drivers and a boiler 58 in. in diameter. The driving-wheel-base is 14 ft. 10 in. and the total wheel-base 22 ft. 10 in. The total weight is 125,600 lbs., of which 109,100 lbs. are on the drivers. The high-pressure cylinder is 20 × 24 in. and the low-pressure 30 × 24 in., the two being connected by a pipe passing through the smoke-box, which serves as a receiver.

ON March 1, according to the tables of the *American Manufacturer*, there were 300 furnaces in blast, with a

weekly capacity of 193,827 tons; a decrease of five furnaces, but an increase of 820 tons capacity, from February 1. As compared with March 1, 1891, the report shows an increase of 50 furnaces in number and of 73,082 tons in the weekly capacity.

There is a large stock of pig iron on hand, and prices are very low. There is a general opinion among furnace owners in favor of reducing production, but no one seems ready to begin the movement.

THE Legislature of Ohio has recently passed a law prohibiting the use of stoves on railroads in that State. The companies are given the option of using continuous steam-heating systems, hot air or hot water. A penalty of $1,000 and of $100 per day is provided for violation of the law.

THE New York Central Company has been notified that its present bridge over the Harlem River is an obstruction to navigation, and must be raised 24 ft. The necessary changes in grade of the approaches cannot be made without permission of the New York Legislature, and a bill for that purpose has been introduced.

To avoid some inconvenient street crossings which will be caused by the change, the company now offers to go back some two miles below the bridge and to build a viaduct from One Hundredth Street to the river, an arrangement which will leave all the street crossings clear of obstruction. The estimated cost of this arrangement is $3,000,000, and the company asks the city to pay one-half the cost.

THE whole matter of the Harlem River crossings has been the subject of so much bad engineering, so many botches and makeshifts, and so much trouble generally, that one is inclined to favor the latest proposition, which is to fill in the Harlem from Third to Eighth Avenue, and thus do away with question of crossings altogether. There are, of course, many objections to this, but it would be at least a settlement likely to remain.

AT the last meeting of the Western Railroad Club, Mr. Forsyth, of the Chicago, Burlington & Quincy Railroad, presented a paper on the strength of car couplers of the M. C. B. type. Mr. Forsyth estimated that there are now probably about 170,000 cars equipped with this coupler. On his own road the breakage amounted to about 7 per cent. of the whole number in use, of which 37 per cent. broke in the arms and 24 per cent. in the knuckles, more than one-half of them through the upper lug. In view of this he has been making some careful tests of couplers made of malleable iron and steel, these tests showing a wide variation in the strength of different types, and serving also to show the weak points in the design as well as the defects in the material. Mr. Forsyth concludes that malleable iron does not possess sufficient strength for the severe service required of a coupler, which in most cases is made to serve as a buffer as well. Cast steel he considers a much better material; but experiments are needed in the methods of casting in order to secure draw-bars free from blow-holes and defects. He would require a tensile strength of at least 125,000 lbs. for the sample coupler, and would provide that test bars must have tensile strength of 70,000 lbs. with an elongation of from 15 to 20 per cent. He also recommends the protection of the couplers by some form of buffer in order to relieve them from many of the violent shocks to which they are exposed.

THE ice-boat, as is well known to those who have used it, can be made to travel at a speed almost equal to that of the fastest locomotive, but it is dependent entirely upon the wind. A Poughkeepsie inventor, Mr. Mulrey, has devised an ice locomotive, or, rather, a steam-engine attachment for the ice-boat which will make it independent of the wind. The boat he uses is of the ordinary ice-boat form, is provided with a small boiler carrying 250 lbs. pressure of steam, and a small engine working on a pair of cogged drivers. Some experiments with this vehicle made on the Hudson River just before the breaking up of the ice were fairly successful.

COLONEL ALBERT A. POPE, of the Pope Manufacturing Company, has undertaken to stimulate interest in the improvement of roads by offering as prizes a large number of bicycles to young men writing the best essays on any phase of the road question. These essays are to be received before May 1 next. The Pope Company has expended a considerable amount of money in preaching the gospel of good roads, and proposes to continue in the same course.

THE Oerlikon Company, in Switzerland, one of the best and most successful manufacturers of electrical apparatus in Europe, has submitted plans for the transmission of power from Niagara Falls to Buffalo. The company has taken all the conditions into consideration, and believes that its plant will provide for all contingencies. They propose the use of units of 5,000 H.P. each at the Niagara stations; the three-phase current in transmitting the power and the use of transformers at the Buffalo terminus. The cost of the plant is given at above $180,000 per each unit of 5,000 H.P. for the complete plant, or $36 per H.P.

THE contract for draining Lake Angeline, in the Lake Superior mining region, has been let to C. B. Howell, of New York. This is quite a formidable undertaking, as the lake covers an area of 153 acres, and has a maximum depth of 43 ft. and an average depth of 20 ft. The contractor purposes using a centrifugal pump with a 20-in. suction and 22-in. discharge, having a capacity of 20,000 galls. a minute; the water is to be pumped into Carp River. The work is to be completed in five months. It is done for three mining companies—the Lake Superior, the Cleveland and the Pittsburgh & Lake Angeline—which own the adjoining lands, and have been working on mineral veins which extend under the lake. It is not considered safe to continue tunneling while the lake is full of water.

THE DE LA VERGNE REFRIGERATING MACHINE.

THE De La Vergne Refrigerating Machine Company, in response to numerous requests and general inquiries from engineers, owners and managers of breweries, cold-storage plants, and artificial ice manufactories, representatives of mechanical and trade journals and others, who desired to inspect a large refrigerating machine being constructed at their works for the Anheuser-Busch Brewing Association, of St. Louis, Mo., issued an invitation to those interested to inspect it on Saturday, March 19, at their works, at the foot of One Hundred and Thirty-eighth Street, New York. A large number of gentlemen availed themselves of this invitation, and inspected the machine and the works in which it was made. It was set up in an annex to the shops at the time it was exhibited, and was all completed. It is said to be the largest refrigerating machine ever built. The gas cylinders are double-acting, 24 in. diameter by 48 in. stroke. The Corliss engine is cross-compound, condensing 600 H.P.; steam cylinders are 32 in. and 64 in. $\times$ 48 in. The machine is 28 ft. 6 in. high and occupies floor space 37 ft. 4 in. $\times$ 22 ft. 3 in. There are two fly-wheels 14 ft. 8 in. diameter. The crank-shaft is made of best selected horse-shoe scrap iron and is 15½ in. diameter, the crank-cheeks being banded with wrought iron straps 2 in. thick, shrunk in. The shaft weighs 20,820 lbs. The compressor connecting-rods weigh 3,400 lbs. each, and the steam connecting-rods and bearings weighed 4½ tons in the rough. The total weight of the machine in the rough was 390,000 lbs.; the finished weight will approximate 175 tons.

The Corliss engine by which the compressors are driven was built by Hewes & Phillips, of Newark, N. J.

To those unacquainted with the industry of refrigerating machinery, the works of this Company were quite a revelation, as the extent to which this class of machinery is now used is not generally known, and the establishment and the work which has been done there is one of very great interest to all mechanical engineers.

The Company has issued several descriptive catalogues, which are models of their kind. They give a brief history

of the science and development of this class of machinery, a statement of the theory to which it acts, and a very full account of the machinery which this Company manufactures. For clearness of statement, conciseness and general satisfactoriness to readers we know of no other catalogues which are their equal, and it is doubtful whether any literature on the subject is in existence which gives so full an account of the art.

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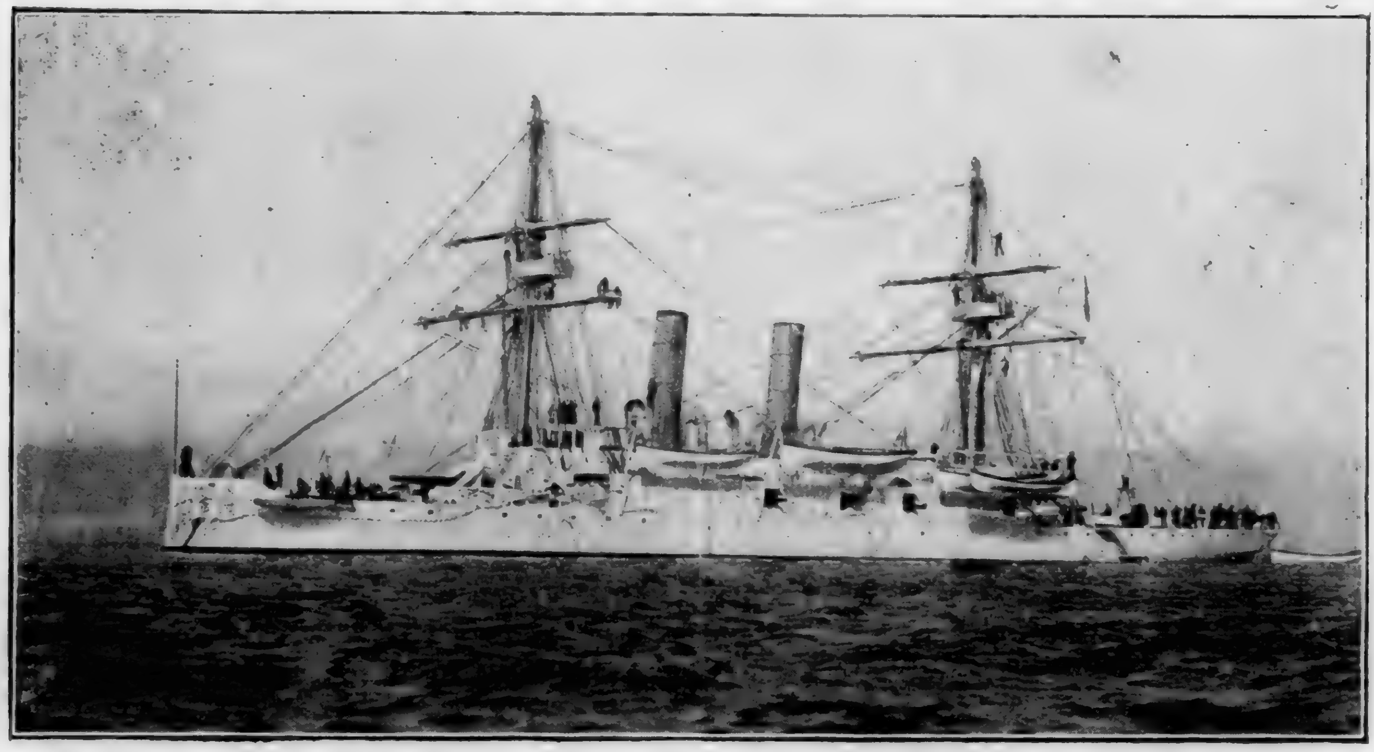

CRUISER "ATLANTA," UNITED STATES NAVY.

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The primary object of a sea-coast work is to prevent the entrance of an enemy's ships into the harbor or roadstead it guards, as well as a sufficiently near approach to shell the city, dock-yards, etc., behind it. Secondarily, it should provide for the protection of the mine-field, which we may always suppose to be present. It may safely be assumed that in future an assault upon a permanent sea-coast work from the sea, by troops landed from boats, will rarely or never be attempted, and that no special provision to guard against such an attack need be provided. It may also be assumed that if the fire of such a work can be sufficiently controlled to permit the clearing of the mine-field, the forcing of a passage by a fleet will be possible. Upon the ability of the fort to maintain an effective volume of fire will depend the value of this line of defense.

It may safely be added that any scheme that proposes to openly expose guns to the fire of the accurate modern high-power rifle will be to invite disaster, and is not to be considered. All authorities now agree in the statement that either the guns must be protected where they stand,

or else must be so mounted that they may be removed from direct fire and the danger of being dismounted except in the brief interval of time required to point and fire them. The removal of the sky-line, as suggested in the article referred to, by the erection of an immense parapet of earth behind the guns, would, with the present means of accurate aiming, only slightly diminish this danger. If we accept General Froloff's rule that the penetration of a projectile into sand, and into a mixture of sand, clay and vegetable mold, free from stone, to be one caliber for every 60 and 40 ft. of striking velocity respectively, it can easily be seen that to provide cover against a 16-in. projectile moving at the moderate velocity of 1,800 foot-seconds would require to construct upon the plan proposed an enormous amount of labor and material. But any thickness of parapet may be granted, and we are still as far from a safe solution of the problem of defending a harbor as before, so long as our guns are exposed to an enemy's direct fire.

In the United States the men who man the batteries and fight the guns have little or nothing to say during the work of preparation. The engineer plans the work, the ordnance officer the gun and its carriage, and when their joint labor is completed it is turned over to the artilleryman, who must stand or fall according as the means and material put into his hands is adequate to its purpose or otherwise. To-day we are committed to the open barbette battery and the disappearing gun-carriage, and the whole question turns upon the point as to whether the disappearing carriage secures for the gun that amount of protection and safety necessary to its efficient service. The writer believes that it does not, and that unless the relative powers of the attack and defense, under present conditions, are wholly misunderstood, the statement will hold that to match open batteries of any kind (for guns) against a fleet provided with a modern armament is certain to invite disaster.

The persistency with which the military engineer clings to the barbette battery is difficult to understand. In 1887, the year after the Fortification Board made its report, in which it recommended, in a general way, armored works in connection with barbette batteries for coast defense, we find in the report of the Chief of Engineers recommendations for the following year, covering the whole coast-line of the United States. These in the aggregate were to be 13 mortar batteries, 30 barbette batteries, the guns on disappearing carriages, and one barbette battery with the guns mounted upon a lift, and fairly ignoring the suggestion that armored batteries were necessary. Two years later we find there has been a change of opinion sufficient to allow works of this kind to bring up the rear of the list in a scheme for coast protection; but it is followed by the statement, in substance, that barbette guns mounted upon disappearing carriages are all that we need concern ourselves with at present. Perhaps this persistency can best be explained by that same spirit of conservatism which prompted the military engineer to go on, up to the middle of the nineteenth century, gravely building in sea-coast fortifications draw-bridge, portcullis, machicoulis, and other like architectural frills, which had their birth in the childhood of the engineering art, and ceased to have practical value with the introduction of efficient projectile arms.

As showing the attitude of the Chief of Engineers and the Board of Engineers of the Army toward this question of gun protection, and of dependence upon mortars, from the report of the Chief of Engineers for 1887, we quote as follows, wherein in replying to the argument that the question of coast-defense should be delayed until the question of the character of the armor to be used was settled, he says:

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The only examples at hand are those afforded by the Civil War, and later, the bombardment of Alexandria. While none of these represent fully the conditions under which future engagements between ships and forts will take place, they do represent them approximately, and, we believe, fully sustain the statement that unprotected guns can never successfully withstand even ordinary shell fire, to say nothing of shrapnel fire, or that from machine and rapid-fire guns.

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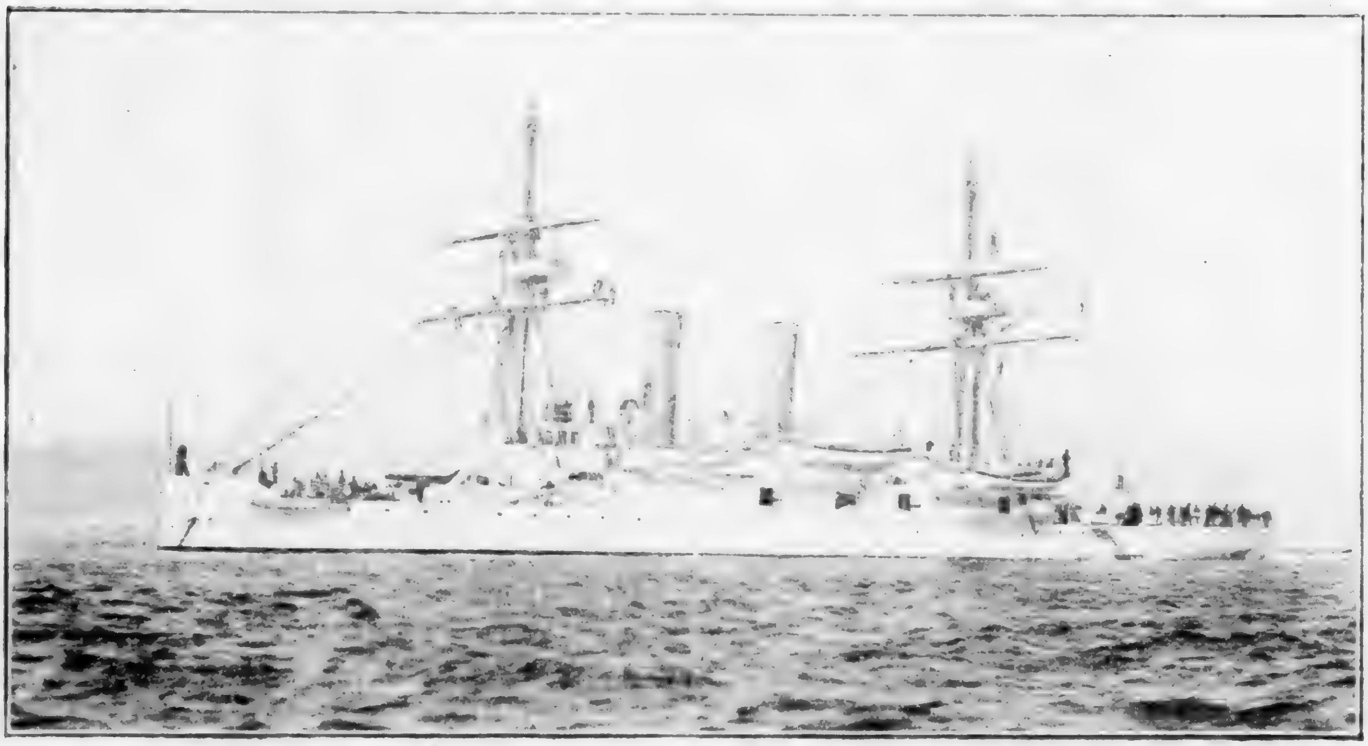

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Pharos, all the guns on shore were in open batteries, the parapets (sand) of which in most cases had been greatly strengthened. Thirty-five rifles and about 75 smooth-bores were actually manned and fired by the Egyptians. The rifles were all in embrasures, and so were much better protected than if mounted in barbette. Admiral Seymour brought against these batteries 8 armored vessels and 5 wooden gun-boats. Before the end of a 10 hours' bombardment, which took place at distances varying from 1,500 to 4,000 yards, the gunners were driven from their guns, the batteries silenced, and 10 of the rifles and 20 of the smooth-bore guns dismounted or disabled.

To fully understand the bearing of these examples upon the point at issue—the possibility, or rather the impossibility of efficiently serving open batteries under present conditions—it must be borne in mind (1) that in no case was the defensive power of the earth parapets injured to an extent that a few hours' work would not have restored them; (2) that the armament in each case was, in great measure, rendered unserviceable permanently or for a considerable length of time, the gunners being driven from their guns, and the batteries for the time being silenced; (3) that in each case the defense was stubborn and the gunnery by no means to be despised; and (4) that, except to a limited extent at Alexandria, this was accomplished with common-shell fire.

(TO BE CONCLUDED.)

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXVI.—HOW TO MAKE SPECIFICATIONS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page* 89.)

IN the course of the articles of this series which have preceded the present one, frequent reference has been made to specifications, to limits of specifications, to revision of specifications, and indeed copies of the 26 or 28 specifications for materials now in force on the Pennsylvania Railroad have been published. It occurs to us that it might not be amiss to say something, growing out of the experience of now some sixteen years, as to the making of these specifications, and accordingly the present article will be devoted to answering the question, "How to Make Specifications."

If we may trust our experience, it is not at all an easy matter to make a specification which will work satisfactorily. Early in our work the making of specifications seemed to be the simplest of all things. All that it was necessary to do, we thought, was to sit down and write what would give a satisfactory material, saying largely what might be regarded as common knowledge; but a long experience has convinced us that such a specification is practically not worth the paper it is written on, and indeed is more of an annoyance than a benefit or help to both the manufacturer and consumer. As time has progressed more and more work and labor have been put on the making of specifications, until now it is not uncommon or rare for a specification to be under consideration six months, a year, or even longer before it is finally issued.

The reasons for the difficulty in making a satisfactory specification are not very hard to find. In the first place, common knowledge often does not cover sufficient ground for a specification based on it to give the material that is needed. Special investigations are needed many times, and indeed, we may say, are almost always required to decide actually what material is wanted in any particular branch of the service. This point will be taken up a little later, and indeed, as will appear further on, the finding out of what is wanted is not at all the simplest part of the work of making a specification. In the second place, specifications are difficult to make because the different parties who are to use the material in the service have quite varying ideas as to what materials should be used, and also have quite varying conditions to meet, so that a material that gives perfect satisfaction in the hands of certain parties and under certain conditions of the service may not give satisfaction at all in the hands of other parties and under different conditions of the service. It is not at all strange, in our experience, to have the same material praised and blamed from different parts of the service. A third reason why the making of a specification is difficult, is because those who are to furnish the materials have different ideas as to what is the most desirable material, and also have different facilities resulting in different costs of manufacture. There is, therefore, a state of affairs among the producers all tending to break down, to interfere with, or to complain of the requirements of the specifications. To meet these complaints, even when they are just, requires no small amount of work. Still another difficulty is that a successful specification must enable the material to be obtained in such a way that it can be tested, and if unsatisfactory returned to the makers, or otherwise disposed of without introducing too great delays in the service or too great expense. This point will hardly be appreciated by those who have not had practical experience in the working of specifications from day to day. Many times in the course of our work we have not put into our specifications desirable clauses or certain tests simply because the introduction of these clauses or tests, while they would secure a better material, would make the specifications unworkable on account of the difficulty of enforcing these clauses or tests without too great delay or expense to the service. Only those who have had experience can appreciate how powerful this influence is. The problem in making a specification is not simply to put in writing something which will give the best material, but to draw a specification that will give a satisfactory material, and at the same time will work smoothly.

In view of the difficulties above mentioned, it is perhaps not strange that we should claim that the making of specifications is not at all an easy matter, and we are confident the experience of all those who are actually engaged in their enforcement from day to day will confirm our view of the case.

It is well known by those who are informed, that there is considerable complaint among manufacturers of what they believe to be unnecessary annoyance and interference with their works and processes, due to specifications, and to such an extent has this matter developed, that at a recent meeting of the American Institute of Mining Engineers the manufacturers actually brought forward the question of trying to completely break down specifications. To our minds, while the remedy proposed by the manufacturers—namely, the abolishment of specifications, and trusting to the maker and his reputation for material, could hardly be approved, there is still much to be said in favor of their position. The real difficulty is that specifications are presented to the manufacturers which never ought to be presented. There is little doubt but that there are hosts of foolish specifications prepared without anything like proper consideration of the subject-matter, and also that specifications are very frequently badly drawn. We are confident that much of the friction between the manufacturers and the consumers would be relieved if specifications that are presented to the manufacturers were much more

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs; No. XXV, in the February number, on Bearing Metals.

carefully drawn. As already hinted at two or three times in what has preceded, as time progresses we are continually using more and more care, and putting more and more study on our specifications before they are issued.

Perhaps it will help us a little in the further consideration of this question to define what we understand by a specification. In its broadest sense, we cannot help thinking that a specification is an attempt on the part of the consumer to tell the manufacturer what he wants. This covers by far the largest portion of a specification. Also, in so far as specifications give limits and methods of testing, they are really in the nature of an agreement between the two parties, having a binding influence upon both. The above view is perhaps somewhat different from the ordinary one. A specification is usually regarded as a means of protecting the consumer, and as something which the producer takes, as he does a dose of medicine, not willingly, but because he must. Our experience and view in regard to specifications that are drawn in such a way as to have unnecessarily objectionable features is, that they are inefficient and, from the nature of the case, cannot be enforced satisfactorily. We accordingly prefer to take the higher ground—namely, that the producer wants to supply what the consumer needs, and that the specification is an effort on the part of the consumer to tell the manufacturer what he wants, and also a mutual agreement between them as to what the material shall be. Based on this conception, we will try to tell in what follows our ideas of how a specification shall be drawn.

First, then, the specifications being an attempt on the part of the consumer to tell the producer what he wants, it is obvious the consumer must know what he wants. How, then, shall the consumer get this information? As already stated, if we may trust our experience, this is no simple matter, and is sufficient reason for consuming considerable time and exercising great care in the preparation of specifications. In general, it may be stated, we think, the best source of information as to what a user wants is the service. That is to say, if you want to know what kind of material you should buy, ask the service. It is obvious this is the court of last resort, and it is consequently the best place to go for information. Our usual practice when we start in to make a specification is to ask, What does the service teach us as to what kind of materials give us the best results? Sometimes in getting this information we collect a large number of worn-out articles, which have given long life and good service, and an equal number, if possible, which have given short life and poor service. Careful examinations are then made of both these lots of samples. To give an illustration, in the case of fire-box steel, not less than 30 worn out fire-boxes were tested physically and analyzed carefully. The results of all these tests being gotten together, the question is, What do these tests teach us as to what gives the best results in service? It is obvious, if the number of samples is sufficiently great, and the teaching from them sufficiently free from contradictory results, that it is possible in this way to get very satisfactory indications, and indeed sometimes positive limitations to be used in making specifications. Such questioning of the service as is outlined above has been made use of in the preparation of quite a number of our specifications, which have already been published, and is constantly being made use of more and more. It will be readily understood that such investigations take time. A single example of good and bad will hardly satisfy, and it takes time to collect together a number of samples which have given good and bad service. Sometimes, likewise, it is difficult to get samples which will compare with each other. The long service of one sample may be due to certain favoring conditions, and the short service of another sample may be due to certain adverse conditions. Theoretically, it would seem as though an investigation carried through a sufficiently large number of samples of good and bad ought to be final authority on what the service teaches; but owing to the uncertainties just mentioned, we are hardly inclined to think that it is quite sufficient to follow blindly what seem to be the teachings of samples from service. We often get strong indications from such examinations; or, in other words, we frequently develop from such examinations a working hypothesis, but it is rare that we simply take alone the results of examinations of good and bad material from the service as final. We always like, however, to start a specification with the examination of materials from service.

It often happens, however, that we cannot get a sufficient number of samples of material that have given good and bad service as readily as we can make a positive experiment, and accordingly we frequently obtain material and put it into service, keeping watch of it to see how it behaves, or in other ways make a positive direct test. We have done a good deal of this work in regard to bearing metals, and also a great deal in regard to the various mixtures of oils to be used for burning and lubrication; also somewhat in regard to materials and proportions to be used in paints. Indications obtained from positive experiments, however, are sometimes misleading, unless great care is taken. Materials that will give perfectly satisfactory results at Altoona will not give perfectly satisfactory results at Wilmington. Moreover, there is always a personal element more or less strong in the use of materials, so that a material in certain hands may give satisfactory results, while in certain other hands it may not; so that we are actually inclined, strange as it may seem, to distrust the results of positive experiments, although the experiments are made by ourselves. On the other hand, the results of positive experiments do give strong indications, and sometimes enable us to set limits which can be wisely adhered to.

These two sources of information—namely, the teachings of good and poor materials taken from the service and actual experiments, as already stated, do not cover the ground completely. Of course, the material must work satisfactorily in the hands of those who are to use it before it goes into the service, and accordingly this source of information is made use of. Consultation with the foremen of the various shops who must use the materials sometimes direct experiments under their supervision, suggested either by themselves or ourselves, and the behavior of the different kinds of materials under these various tests throw much light on the subject. Upon this point of consultation with those who must use the material, we would like to say that, as a matter of policy in the preparation of specifications, it is extremely wise, and it is also wise to make the consultation as broad as possible—that is, do not try to get all your information as to the practical working of materials from one foreman. Comparison of views and comparison of experience from the different foremen throw much light on the subject. Moreover, if those who must use the material are consulted in the preparation of the specifications, they will, when the specifications are finally issued, be much more kindly received and more readily given a helping hand than if the specifications are prepared without their having any voice in the matter.

There is still another source of information which should not be disregarded in the making of specifications, and this is a careful examination and investigation of every piece of material that fails in the service. This is especially true of the breakage of parts made of iron or steel. We have gathered very much valuable information to be embodied in our specifications from this source, and indeed the examination of material that gives short life, or that fails, or that does not work satisfactorily is very often the starting point of the specifications. Something occurs in service that is a little abnormal; a study is made and information gathered. Possibly the same thing is repeated at another portion of the road within three months. Another investigation is made, and possibly the teaching may be the same, or it may throw additional light on the cause of the failure, and so on, until perhaps a dozen cases have occurred. If the teaching is plain enough on the first investigation to cause a change in practice, this is at once made use of, and the subject is held under advisement, for the accumulation of further information which shall lead to positive specifications.

Still another source of information which may be made use of in the preparation of many specifications is to examine the materials that the market affords. Manufacturers of the kind of material in question are asked by the Purchasing Agent to send to the Laboratory a sufficient sam-

ple of such material as they can furnish, and furnish regularly and satisfactorily. After these materials are received they are carefully subjected to analysis, or physical test, as the case may be, and the results tabulated and studied. This gives the man who is to write the specifications a knowledge of what actually is being done or can be done in the market. This source of information, however, is not wholly reliable, and if in making specifications one follows the teachings of such procedure as is outlined above, he will not infrequently run across difficulties later on. The reason for this is that manufacturers are inclined to put their best foot forward, and consequently send for examination a little better material than they can make regularly. It is not uncommon to find that we have placed limitations in specifications, which limitations were dictated by the analyses of the material that the parties have furnished themselves, and yet when we come to get shipments, the material will not pass the requirements. So much is this the case, that we have sometimes had to modify our specifications later on. This peculiarity, if we are rightly informed, agrees with the experience of other parties. Many of the Government specifications, based on correspondence with the steel manufacturers, have run across the same difficulty, because the manufacturers, in competition with each other, stated a little more than they could regularly and uniformly perform. Looked at in this light, of course it is the manufacturers themselves who are to blame for harassing specifications.

Another source of information, and one frequently made use of before the specification is put in writing, is to visit the various works where the materials in question are made. It is obvious that the man who draws the specification, in order to make it work successfully and smoothly, must be able to do justice both to the service, where the material is to be used, and also to those who are to make the material, and it not infrequently happens that by an inspection of the materials used in the manufacture and the processes used, and by consultation with those who make the materials, he gets such information as enables him to avoid putting into the specifications requirements which are unwise. We are very strongly of the opinion that the man who attempts to write a specification without any knowledge of the processes by which the material is made will make a serious blunder. The more intimate the knowledge of the process, the more wisely the specifications will be drawn.

We conclude, then, that for the purpose of getting the information necessary to make a specification, the following sources are all available—namely, *first*, study of good and bad materials which have given service ; *second*, direct experiment on materials in service ; *third*, consultation with those who must use the materials in service ; *fourth*, examination of materials that fail in service ; *fifth*, examination and test of materials from different manufacturers, and, *sixth*, visits to and study at the works where the materials are made.

It will be observed that we have given above practically six different sources of information, all of which should or may be studied before one sits down to write a specification. It is perhaps not too much to say that in most of the specifications in use on the Pennsylvania Railroad information has been accumulated from almost all of the above sources before the specifications were written out. Sometimes, according to the circumstances of the case, one source has thrown more light on the subject than another, and sometimes the necessity for action in the matter of securing better materials than we were actually receiving has been so great that we could only obtain information from one or two of the sources before putting out a preliminary specification. But we cannot but think that it is extremely desirable to have each of these sources of information probed as far as possible before the specifications are made. The more care and study there is expended in collecting information before the specification is written, the more likely the specification is to work smoothly after it is written.

Let us suppose now that sufficient information has been obtained from the different sources, so that it is deemed advisable to embody it in the form of specifications ; the person who is to do the work gets the information together, sifts it, and gets the teaching from each point, and sits down and puts in writing the proposed specification, embodying all the information as best he can. It is our practice in doing this to give a pattern, or practically describe in brief the material desired. Following this are usually discussions of the methods of selecting the sample, methods of testing, under what regulations the material will be bought, and finally the limitations are given upon which the materials will not be accepted. This information having been drawn up, it is put in print in proof form, and copies are sent to the various officers of the road, who are most closely interested in the use of the material, and also to the Purchasing Agents, with the request to the latter that they distribute the proofs to those from whom they desire to purchase this material, and ask for their criticism. This method of consulting the manufacturers who are to furnish the material is entirely characteristic of all our later specifications, and we feel that it is essential.

This leads us to the second clause in our definition of specifications—namely, that, assuming that the manufacturers desire to furnish what the consumer wants, the specification is really in the nature of an agreement between them, and consequently the producer has a perfect right to be consulted in the making of the specification. Moreover, the knowledge which the producer has of the capabilities of his works, and of what the various processes will yield, is necessarily more intimate and valuable than can be obtained by the person who writes the specification, unless the latter happens to have especial experience in the manufacture of that kind of material, so that the consumer is really shutting out a valuable source of knowledge unless he consults the manufacturers. It is, of course, fair to say that many manufacturers are inclined to bend the specifications to suit their individual circumstances, and we have had very many amusing criticisms and suggested modifications of our specifications sent us in reply to our request for suggestions. On the other hand, we have no hesitancy and no embarrassment in saying that many of the limitations and conditions of our specifications have been suggested by the criticisms of the manufacturers. Some of the limits, and, indeed, the wording in some cases have been taken from the criticisms of the manufacturers on our first draft in proof form.

There is another phase of this case—namely, that if the manufacturers are consulted beforehand in the making of the specifications, they are well informed as to what the demands and growth of knowledge from the consumer's standpoint are going to require of them. Still further, they are conciliated, and they are much better prepared to give the specification a kindly welcome when it is issued than if a full-fledged specification is presented to them that emanates from the brain of some, perhaps, a little too over-confident person. If we may judge from our experience, it is a foolish man who attempts to issue a specification for any kind of material without consulting those who are to make that material for him.

The criticisms from the manufacturers and from the various officers above referred to having been received, these are all sifted, and such modifications in the original draft as seem wise are introduced. It is fair to say that it is not possible always to follow all the suggestions of the manufacturers, and we have found quite to our gratification that the criticisms of the manufacturers were a pretty good antidote to each other. Where they all agree upon a point, it is usually wise to follow their suggestion. Where some are on one side and some on another on a disputed point, you are fairly safe in following your judgment between the two.

While this criticism and discussion is going on, it is usually our custom to have sent to the Laboratory samples from the shipments of the material under discussion, and examine these in the light of the proposed specifications. In this way we accumulate a certain amount of information that we can get in no other way. In reality, we assume, for the purpose of the Laboratory work, that the specification is in force, and examine all the shipments of the material that are received, just the same as though they were in force, the only difference being that if we find the shipments do not conform to the specifications, we do not reject them, because they were not bought in accordance

with specifications. We were led to this method by finding that usually, after all our care in making specifications, something would occur, within the first six months of their actual working, which would demand a modification, and so we utilize all the time we can in getting experience with the specifications before they are issued. Moreover, the manufacturers of many commercial products are frequently not fully informed of their own product, and the information collected in this way from the examination of shipments of their material is often sent them for their guidance and knowledge.

The criticisms all being in, and experience being obtained, the specifications are finally issued. It is perhaps not too much to say that in important specifications, with all our care, we still have to revise from time to time. Progress in knowledge, changes in our practices, and many times changes in methods of manufacture lead to these modifications. It is no small work to keep up with the development and changes in the methods of manufacture for the various articles for which we now have specifications. Again, each manufacturer is constantly trying to make a material which will meet the limits of the specifications at less cost to himself, and it not infrequently happens that this leads to the production of a material which is inferior. The specifications must therefore be modified to meet this peculiarity.

We are quite well aware that it is probable the criticism will be made by many engineers, that if our method of making specifications were followed, there would be no specifications, as many times it would be impossible to have such facilities and access to sources of information as will enable study enough to be put upon the subject to make a specification wisely. It will undoubtedly be urged that many specifications must necessarily be made from common knowledge, and also that in many cases the consumer knows without special study what he wants, which is simply the best which can be made of the kind.

In reply to this we would say that we are quite familiar with the emergencies which are constantly occurring, and which lead to action on insufficient knowledge. No class of men in the community are meeting emergencies more constantly than railroad men, and it not infrequently happens in our experience that we are called upon to make specifications without having given the matter sufficient study. In such cases, recognizing that our knowledge is limited, we have thus far drawn specifications so as to overcome the difficulty which gave rise to the necessity for action, but at the same time in such a way as not to cause hardship to those who must furnish the material. In other words, we cannot but conceive it wise, if we do not have positive knowledge, which leads to a rigid demand on the manufacturers, it is much better to make the demand one that can be fairly easily filled. We are perfectly rigid and unyielding where the service furnishes the information leading us to take such a position, but where it is a question of judgment, where limitations must be placed on general information, we submit that it is wise simply to make the limits such that they will not cause unnecessary annoyance to those who are to fill the specifications. To put the whole matter in a single sentence, we cannot but feel that in many cases a specification is made a place to show how much the man who draws it knows. We also feel that this is certainly unwise, and that the interests of the service will be equally well protected without many of the narrow limitations and tortuous tests which are characteristic of some of the specifications which have come under our eyes. A mild specification rigidly enforced is infinitely better than a rigid specification, with constant jangling and constant yielding by the inspector to allow materials to pass.

In the next article we will try to say something about Sampling, and the Enforcement of Specifications.

(TO BE CONTINUED.)

COLUMBIAN EXPOSITION NOTES.

It is announced that the Pennsylvania Railroad Company will make a fine exhibit in the Transportation Department, and that the New York Central & Hudson River and its allied companies will also make a large exhibit. Both of these will be planned and arranged to illustrate American railroad practice on the most improved lines; they will also be historical in their nature, and will show the growth of the several systems. Mr. T. N. Ely has charge of the preparation of the Pennsylvania Railroad exhibit.

Seven of the World's Fair buildings are now so far advanced that they are fast assuming the appearance of finished structures. The rough carpentry work on them is practically done, and the ornamental and finishing work is in progress. These buildings are the Woman's, Horticulture, Transportation, Mines, Administration, Forestry and Fisheries. Five more—the Government, Fine Arts, Agriculture, Dairy and Illinois State—are erected to the roof lines. The Electricity, Manufactures and Machinery buildings are being advanced rapidly.

Plaster work on the Mines Building is finished; the gallery railings are nearly completed, and wire work is being set. Staff work on the south end of the building is nearly finished. All of the carpentry work and iron work on the Transportation Building is in place except the central elevator tower.

All of the trusses of the Electricity Building, with the exception of the central diagonal trusses, are in position.

On the Administration Building 160,000 ft. of lumber and 20,000 lbs. of iron have been added during the week. Roofers are working on the northeast and northwest pavilions.

On the big Manufactures Building the record shows a total of 9,797,152 ft. of lumber used, in addition to which has been received 444,000 ft. of lumber and 168,000 lbs. of carpenters' iron. The great traveler which is to be used for hoisting the immense girders spanning the central court is already 120 ft. high, and is yet less than half completed. When completed it will be used for putting in place the largest trusses ever made for architectural purposes, spanning 368 ft. and rising to a height of 211 ft.

The iron work for the dome of the Fisheries Building is complete, and staff work is nearly finished in both annexes.

Ornamental staff work is being rapidly placed on the west end of the Agricultural Building, and the roof trusses over the nave and transept are in position. The iron for the entire building is on the ground, and the walls for the south half are about ready for the roof iron.

Work on Machinery Hall has been retarded, owing to non-delivery of iron, but the total amount of lumber placed foots up 30,000 ft., and iron, 102,000 lbs. Most of the carpentry work has been to frame the annex superstructure. The second of the large arches is now in position.

Work on the Dairy Building is nearly finished, also on the Forestry Building. The latter is being temporarily used as a shop for the molders who are casting the big figures and groups for the Administration Building.

SOME NEW COMPOUND LOCOMOTIVES.

A COMPOUND consolidation locomotive of the pattern devised by Mr. F. W. Johnstone, of the Mexican Central Railroad, was described in our columns some time ago. Mr. Johnstone has now completed plans for a double-bogie compound engine, and several locomotives of this pattern are to be built for his road. The engines have two boilers placed end to end, the fire-boxes adjoining each other and the fire-doors being at the side. The boiler and the cylinders will be carried on a rigid frame, but the running gear will be arranged in two groups, each group forming an independent truck. The plan is in outward appearance somewhat similar to the Fairlie double-bogie engine, which attracted considerable attention some years ago, but with the essential difference that in the Fairlie system the cylinders were carried on the truck frames, while in Mr. Johnstone's plan the cylinders are secured to the boilers and to the main engine frame. The piston-rods of the engine work on the upper ends of levers carried in bearings on the main frame, and the connecting-rods are attached to the lower end of these levers. Each of the truck frames carries three pairs of coupled driving-wheels and a two-wheeled truck, the radius-bar of this truck being pivoted to the front of the truck frame. The

engine will have no tender, the water being carried in saddle tanks. The cylinders are of the type patented by Mr. Johnstone, the high-pressure cylinder being placed inside the low-pressure, the latter consisting of a ring or annular cylinder around the high-pressure.

The boiler, or rather boilers, of these engines will be 52 in. in diameter, and will have 201 tubes 2 in. in diameter and 15 ft. 9 in. long. The fire-boxes will be of the Belpaire type, 56 in. long and 56 in. wide inside. As they are placed between the trucks, opportunity is given to make them of unusual width. The driving-wheels are 48 in. in diameter and the truck wheels 28 in. The trucks are of the swing-bolster pattern. The high-pressure cylinders are 13 in. in diameter and the low-pressure 28 in. outside diameter. The ratio of the cylinders is about 1 : 2.8. The valve motion is outside, and is worked directly from the crosshead, no links or eccentrics being used.

The tanks will have a capacity of 3,000 galls., and the coal bunkers, which are placed at the side of the engine, will hold about 5 tons of coal. The total weight of these engines in working order will be about 230,000 lbs., of which 200,000 lbs. will be carried upon the driving-wheels.

The peculiar features of these engines are covered by patents issued to Mr. Johnstone; and he claims that they will be well adapted for the difficult mountain service of the Mexican Central and on railroads of the similar class.

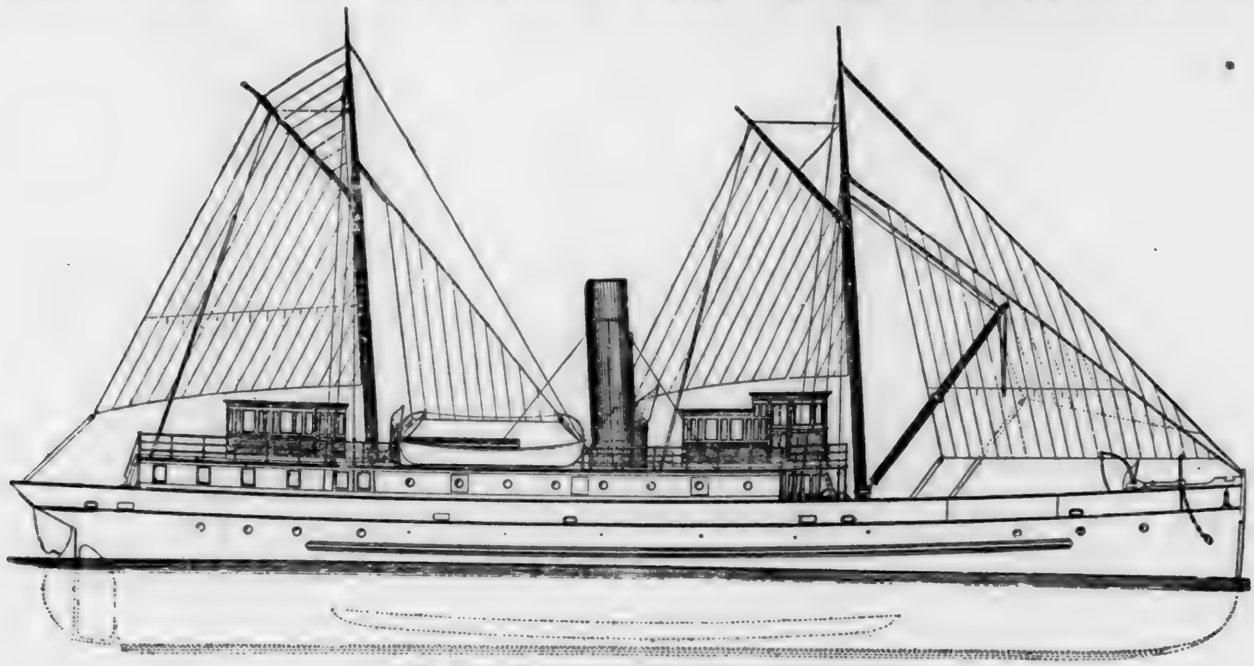
NEW LIGHT-HOUSE TENDERS.

(From the Cleveland *Marine Review.*)

Two light-house tenders, the *Lilac* and *Columbine*, building at the yard of the Globe Iron Works Company, Cleveland, O., to go, respectively, to the First Light-house District with headquarters at Portland, Me., and the Thirteenth District with headquarters at Portland, Ore., are described in the annual report of the Light-house Board just issued. These boats as they appear on the stocks at the yard of the Globe Company are of great credit to the officers of the Light-house Board, as well as the builders. They are duplicates; and it may be said of them in a general way that the hulls are as fine in appearance as either of the costly steam yachts that left the stocks in Cleveland recently, and their engines are as neatly built as anything ever turned out by the Globe Company. They will prove good specimens on the Atlantic and Pacific coasts of the work of lake ship-builders. Another light-house tender for lake service, the steamer *Amaranth*, is nearing completion at the yard of the Cleveland Ship Building Company, and four others, lightships for the Atlantic coast, are under way at the yard of F. W. Wheeler & Company, West Bay City, so that shortly after the spring opening seven boats will be turned over from lake builders to the Light-house Department, six of them going to the coast.

The engraving shows the general plans of the *Lilac* and *Columbine*. The material is Siemens-Martin mild steel, and the dimensions are: Length over all, 155 ft.; length from inside rudder-post to inside stem, 145 ft.; beam molded, 26 ft. 6 in.; depth of hold from top of beam to top of keel-plate, 15 ft. 2 in.; depth of hold from top of beam to top of double bottom, 12 ft. 4 in.

The vessels are fitted with a double bottom; inside height of this double bottom, in the clear between plates amidship, will be 34 in. The vertical center keel-plate runs from end to end of the vessel, tapered forward and abaft the double bottom, to the height of keelsons at these places; it forms the keelson and extends down to the skin of the vessel for three frame spaces, the floor plates on these frames being cut and securely riveted to the center keel-plate by angles 3 × 3 in. × 6 lbs. The side keelsons or girders also run continuously, the floor plates and brackets between the girders being cut. This double bottom is divided into four separate water-tight and independent compartments, each provided with a sufficient number of manholes properly constructed and so located that access can be had at all times to every compartment for cleaning and other purposes. There are seven water-tight bulkheads dividing the parts of each vessel above and forward, and abaft the double bottom, into eight water-tight compartments. The vessels are built with a flat plate keel in double thicknesses and provided with an extra protective keel, also with one outside bilge keel on each side of the vessel. The vessels are rigged as two-masted schooners, with pole topmasts, gaffs and derrick booms. Each will be supplied with a steam windlass, steam hoisting engine, and the best appliances for handling anchors, buoys, and cargo or any other purpose required by the service. An electric plant for operating a search light and for illuminating all parts of the vessel will also be a feature of importance.



NEW LIGHT-HOUSE TENDER "LILAC."

There is for each steamer one right-handed cast-iron screw propeller about 9 ft. 4 in. in diameter and of suitable pitch, driven by an inverted cylinder, surface condensing, fore-and-aft compound engine; the cylinders are 22 and 41 in. in diameter, with a stroke of 30 in. The steam is furnished by two cylindrical single-ended boilers 10 ft. 8 in. in diameter and 10 ft. 9 in. long, each fitted with corrugated furnaces.

In addition to the necessary trials of the machinery at the dock a trial trip is also to be made of about 12 hours' duration, and the engine must develop 600 indicated H.P. when making 110 revolutions per minute, with a coal consumption of 2¼ lbs. per indicated H.P., and steam, per gauge, at 100 lbs. pressure per sq. in.

SOME STANDARD COAL CARS.

THE illustrations herewith show three different styles of coal cars, and are of interest as illustrating the different

Fig. 2.

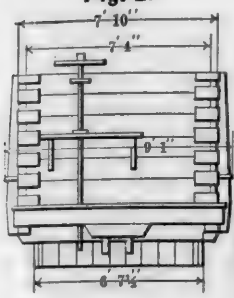
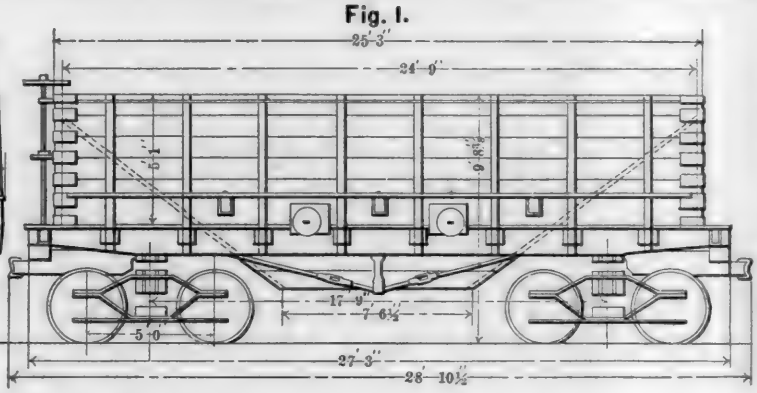


Fig. 1.



types which have been found serviceable in the same traffic.

Figs. 1 and 2 show a side elevation and end view of the standard hopper-gondola in use for coal traffic on the Baltimore & Ohio Railroad. The general dimensions are shown in the engraving: The length of the box inside is 24 ft. 9 in. and the width, 7 ft. 4 in. The hopper has two clear openings, each 35 in. × 76 in. in size. The weight of the car is 29,700 lbs. and its capacity, 60,000 lbs.

Figs. 3, 4 and 5 show an experimental iron coal car built for the same traffic; fig. 3 is a side elevation, fig. 4, an end view, and fig. 5, a half plan. The car frame is of wood and the box of iron, with cylindrical ends. The box is 7 ft. 6 in. wide and 21 ft. 6 in. long;

Fig. 5.

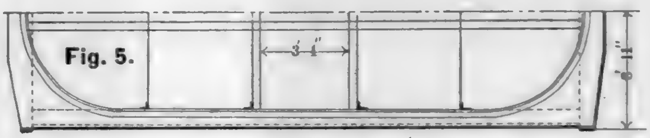


Fig. 4.

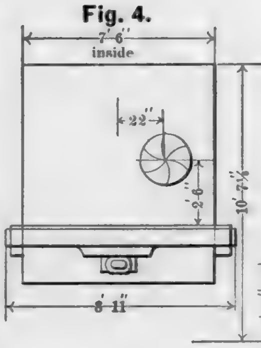


Fig. 3.

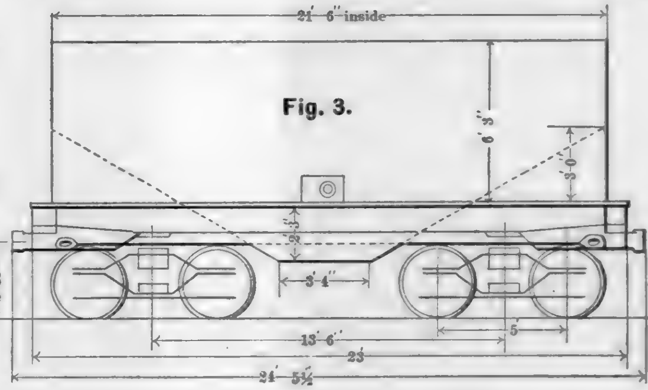


Fig. 7.

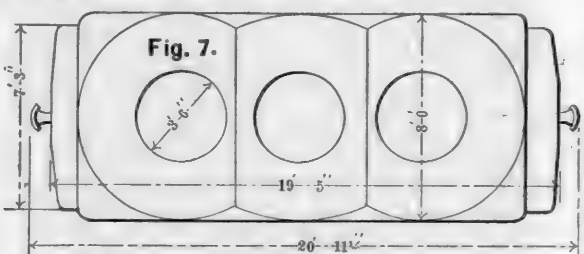


Fig. 8.

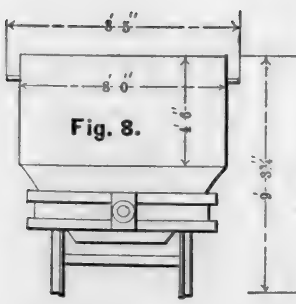
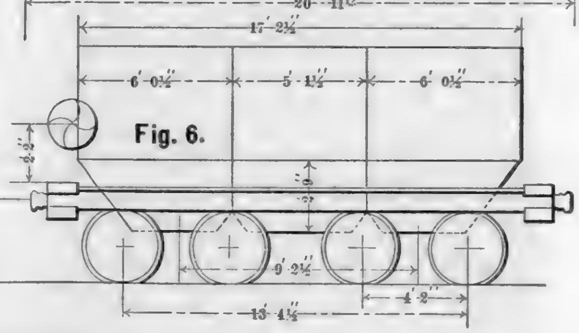


Fig. 6.



the hopper opening is the full width of the box, and 3 ft. 4 in. long. This car weighs, empty, 26,800 lbs., and has a capacity of 60,000 lbs.

Figs. 6, 7 and 8 show the latest improved form of a type of coal car which has been in use on the Baltimore & Ohio for many years, and which is peculiar to that road. It is an iron coal hopper, the box or body being of iron, composed of three intersecting cylinders, and having three hoppers for discharge. The general form and dimensions are so fully shown that little further description is needed. The latest form, shown in the drawings, has a capacity of 40,000 lbs. of coal, and its weight, empty, is 17,050 lbs. It may be said that this type of car has some good points about it which are worth considering.

Figs. 9, 10 and 11 show respectively a side view, an end view and a plan of the standard freight truck in use under the cars shown above. The axles of this truck have $4\frac{1}{4} \times 8$-in. journals; centers of journals, 6 ft. 3 in. apart. The springs are of the helical type. The axles are spaced 5 ft. between centers, and the wheels are 33 in. in diameter. The truck is of the diamond type; the bolster is composed of three timbers, the middle one being $4\frac{1}{2} \times 10\frac{1}{2}$ in., the two outer ones, $3\frac{1}{2} \times 10\frac{1}{2}$ in., the space between each being ¼ in. This form of bolster is not a usual one. This truck is used under several different classes of freight cars.

All these types of cars have done and are still doing excellent service on the road, chiefly in carrying bituminous coal, in which a very large business is done by the line on which they are in use. Each of them has some points of excellence about it.

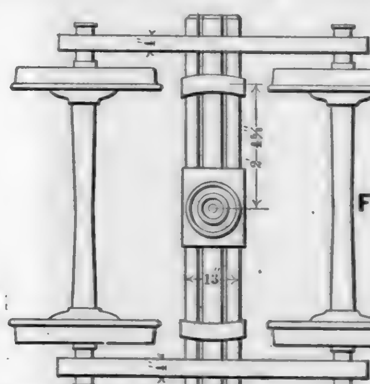


Fig. 11.

Fig. 10.

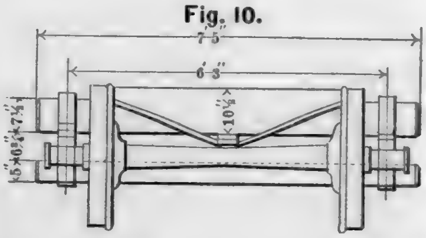
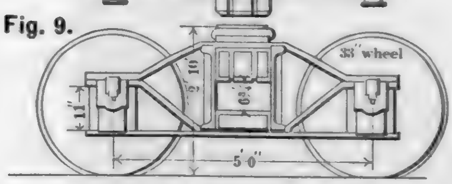


Fig. 9.



A DISCUSSION OF THE POSSIBILITIES OF THE M. C. B. COUPLER.

By Edward P. Eastwick, Jr., C.E.

At the Convention of the Master Car Builders' Association, in 1887, the Committee on Automatic Freight Car Couplers, in recommending the Janney type of coupler to be adopted as the standard of the Association, stated, in substance in its report, that while this selection had been the result of a careful study of the superior mechanical features of the device and its adaption to the requirements of practical service, it was far from being considered perfect in many important details. The various advantages over other types of couplers were enumerated, but at the same time serious defects were pointed out, and especially that of insufficiency of strength, a fault common to all forms. It was the opinion of the Committee, however, that this defect was remediable, and that the future development and perfection of the device should be in that direction.

It is now nearly five years since the M. C. B. type of coupler was adopted by the Association, and that it has fully merited the preference it received has been clearly demonstrated by the record of its practical performance during that time. Although at first met with considerable opposition on the part of advocates of the link-and-pin and the automatic link coupler, it has steadily advanced in the favorable estimation of railroad men in general, and within the past three years the equipment of freight cars with this coupler has increased to such an extent that it now seems eventually destined to replace all other forms of car-coupling devices.

But practical experience has brought about many changes, and has shown that the defects in the coupler, indicated in the Committee's report above referred to, were of a nature requiring immediate attention and prompt remedy. The desirability of simplifying the action at once became apparent, and therefore soon after the introduction of this type of coupler the various designs of the several manufacturers then in existence and use underwent radical alterations; spring operating locks, which were found to become quickly disordered, were generally discarded, and in most instances replaced by a simple direct acting gravity lock; means were also taken to overcome the evil effects of wear and lost motion thereby developed at the lock and pivotal point of the knuckle, which was most disastrous in allowing couplers to come apart, especially in those forms having the shortest arm and consequent greatest leverage acting on the lock. Many of the couplers found insusceptible of improvement in this regard went out of existence and new ones otherwise adapted sprang up in their place.

But in all the most prominent and serious defect developed, and seemingly one inherent in this type of coupler, which occasions the greatest difficulty in attempting to overcome, is that of lack of durability and insufficiency of strength, especially in the knuckle; and indeed so serious has this proved to be that it at one time almost threatened the downfall and abandonment of the type. Improvements in construction as regards remedial effect in this direction have, however, been made to a considerable extent.

Constrained by the requirements of reciprocal intercoupling and consequent conformity to a restricted contour, the limits of increased dimensions were soon reached, varying somewhat in the different devices. Further improvement, therefore, was next sought in the employment of a superior quality of material, and thus followed a gradual transition from cast to malleable or wrought iron, and then, particularly in the case of the knuckles, from wrought iron to steel.

At the present time the M. C. B. Coupler is still undergoing constant changes to meet the severe requirements of freight service. Its principal dimensions are now narrowly limited by the action taken by the Master Car Builders' Association at the last convention in requiring the close adherence to the standard contour, but in other respects the coupler may yet be said to be in a state of development Whether the necessary and desirable degree of strength has or can be attained in this type of coupler in any of the forms now in use, or is likely to be attained in any further variation, is a question that future experience and time must answer. That it is capable of greater strength and endurance than has yet been reached would seem most probable in view of the results of a scientific investigation of its possibilities. The consideration of the manner in which the forces and strains in the different parts of the coupler may be distributed and modified leads to this conclusion.

The purport of this article is to treat of the strains sustained by couplers of various designs when in active service, and to show by both graphical and mathematical demonstration the advantage or disadvantage the coupler may be subject to under them; moreover to indicate in what manner the forces and strains may be distributed by special construction either for the purpose of equalization or action in a desired direction; and finally to fully consider the effects of wear and deduce the general formulas for same. It is not the intention to reflect on any makes of couplers now in the market or in use, and any resemblance that may be found to the forms herein selected for illustration is purely incidental, as must be the case with all couplers of this type.

The investigation will be confined simply to the determination of the directions and intensities of the forces sustained by a coupler when subjected to both a pulling and buffing force, and will illustrate by diagram the changes which take place in them, resulting from alterations in the relative positions of the lock and pivotal point of the knuckle, the surface for resisting a buffing force in the drawhead, and the lines of action of the pulling and buffing forces. At the same time the incidentally advantageous and injurious effects will be pointed out.

In the first place, that form of M. C. B. Coupler will be considered in which the lock and pivotal point are on the same side of the drawhead, and where also the buffing strain is sustained. The bearing face of the lock is parallel to the center line. This is represented in the accompanying drawing by fig. 1, in which the knuckle is shown as it would be in a closed and locked position in the drawhead, the latter being omitted in the drawing as not being necessary to our present purpose. The knuckle is pivoted at O and the lock is at F. We will presume the pulling force to be acting at Q along the line $L\ L$, which is the center line of the coupler. A force is thereby caused to bear at both the lock and pivotal pin. Assuming that there is no frictional resistance at the lock, which is admissible in this connection, as it in no way deteriorates the value of the deductions to follow, the force caused to act on the lock (and consequently the resistance offered by the lock) will be in a direction perpendicular to its bearing surface, for the reason that in that case it is incapable of resisting a force in any other direction.* Now the pulling force, the resistance offered by the lock, and that by the pivotal pin at the center of revolution of the knuckle are in equilibrium; hence if $F\ A$, perpendicular to the bearing surface of the lock at its center point, represents the line of action of the resistance and intersects the line $L\ L$ at A, then a line drawn from A to O gives the direction of the force and resistance acting at the pivotal pin, and the intensities of each of these forces can be readily determined.

Since the graphical statics is the more easy of application in this case, and is therefore preferable to a laborious analytical calculation, it will be herewith employed. At the same time it will give the means of comparing results by mere inspection and thus of quickly obtaining relative values, which are all that are at present desired.

On the line $L\ L$ lay off $A\ C$ (fig. 1) to any convenient scale, so that it represents the pulling force according to a certain ratio. If then the dotted lines $B\ D$ and $C\ D$ are drawn parallel to $A\ C$ and $A\ B$ respectively, a parallelogram, $A\ B\ C\ D$, will be formed, from which, by the well-known principle of the parallelogram of forces, the forces

* The effect of frictional resistance at the bearing surface of the lock in modifying the intensities and directions of the forces acting at the lock and pivotal pin, as will be subsequently seen, is considerable. But in the present instance the results to be obtained are simply relative, and as the general effect of friction is similar in each case to be taken up it may be entirely neglected, and in no way detracts from the practical value of these results. The effect of friction will, however, be fully explained later on.

acting at the lock and pivotal pin are at once found. Thus the force at the pivotal pin acts along the line *A O* in the direction indicated by the arrow, and its intensity is represented by the line *A D* measured by the same scale adopted for *A C.* In like manner the direction and intensity of the force acting against the lock is given by the line *A B.*

By a similar method, if the buffing force is taken as acting at *Q'* along the line *S S,* the resulting force at the pivotal pin and point of resistance in the drawhead *M* may at once be determined from the parallelogram *Y I N S,* and by modifying the positions of the lock, pivotal point and point of resisting a buffing force in the drawhead, relative to each other and to the lines of action of the pulling and buffing forces, the intensities and directions of the forces produced at these three points may also be determined for different conditions.

Figs. 4, 5, 6 and 7 represent in this respect examples of practical adaptation. In each case *A C* represents an equal pulling force and *S Y* an equal buffing force laid off to the same scale used for fig. 1. The variation in the forces produced are thereby displayed, and comparisons may readily be made by simple inspection.

Referring again to fig. 1, it will be seen that a pulling force, *A C,* induces a force, *A D,* at the pivotal pin, which latter is the greater of the two; that is to say, the lock having its bearing surface parallel to the pulling force is incapable of directly opposing it, but simply acts as a stop to the induced force of leverage in preventing the outward movement of the knuckle and the relative positions of the line of action of the pulling force, the lock and pivotal pin are such that the force is increased at the latter point. As the bearing face of the lock changes in direction so as to incline toward the center line, or line of action of the pulling force, it commences to take a part of that force directly, which increases as the angle approaches 90°. At the same time the portion of the force will also increase as the position of the lock approaches the center line; and if the position of the pivotal pin remains constant, the force to be resisted at this point will proportionately decrease. This will be made clear in the cases immediately to follow.

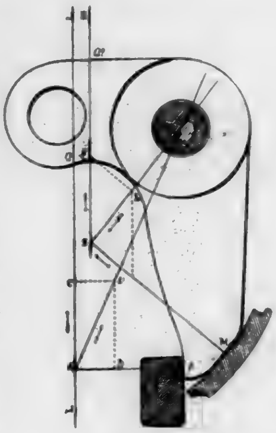


Fig. 1.


Fig. 2.

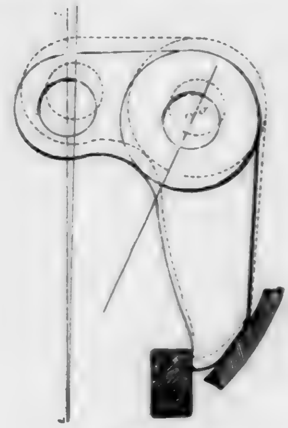


Fig. 3.

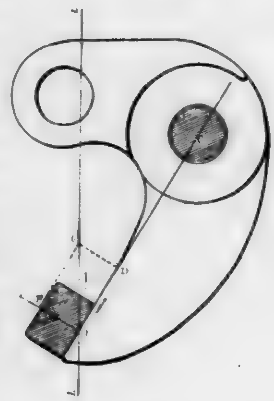


Fig. 4.

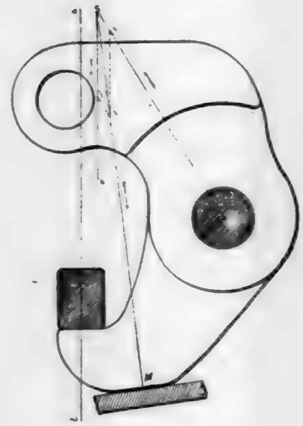


Fig. 5.

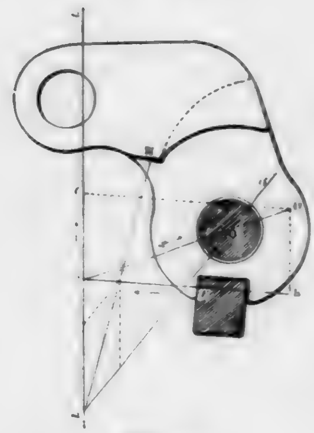


Fig. 6.

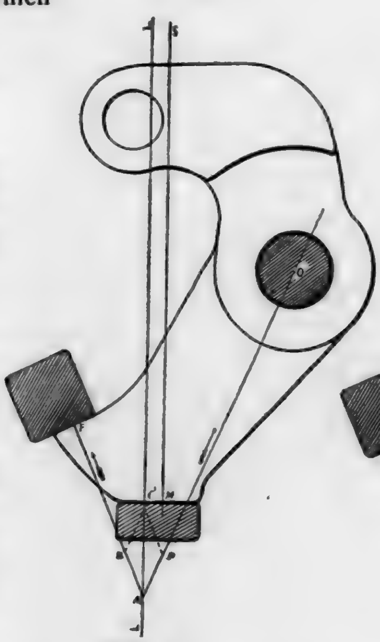


Fig. 7.

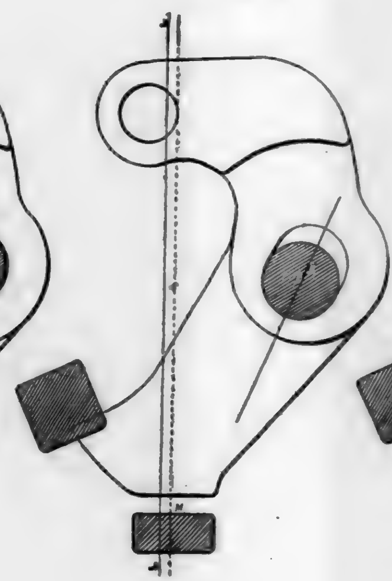


Fig. 8.

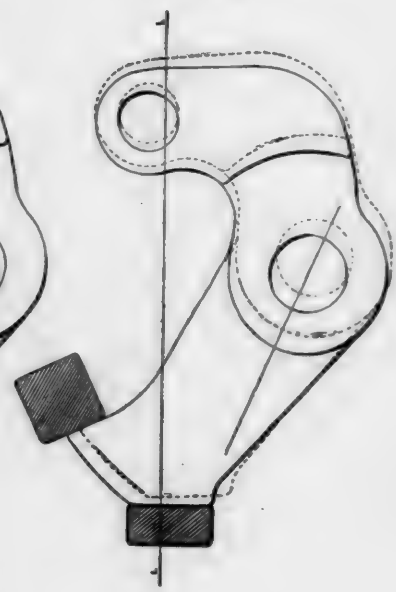


Fig. 9.

In fig. 4 is illustrated a coupler in which the lock is exactly central, and the direction of its bearing surface coincides with a radial line drawn from the center of revolution of the knuckle. In this instance the force at the pivotal pin is much less, and the pulling force is more equally distributed to the knuckle and drawhead than in the foregoing example. If the lock remains in the same position on the center line, but the direction of its bearing surface changes so that it becomes at right angles to this line, as shown in fig. 5, there is again a condition which causes a pulling force to be resisted alone at one point. Here the entire pulling force is sustained at the lock, and no force whatsoever acts at the pivotal pin. In fig. 1 the opposite is nearly true, although the lock in this case sustains an indirect force, greater or less, depending upon the distance of the lock from the pivotal pin.

In a coupler designed as indicated in fig. 1, the hinge or pivotal pin of the knuckle must necessarily be located well forward in the drawhead, and as the force bears at this point, the strain at times becomes very great. Even a steady, straight pull equivalent to the ordinary draft power of a locomotive exerts a force against the pivotal pin of not less than 12 tons under the most favorable conditions, and the effect of shock, to which a coupler in use is more or less subjected, is to greatly increase it. The lugs of the drawhead, through which the pivotal pin passes, receive this entire strain, and the hauling consequently takes place wholly at these two points, or, in other words, from only one side of the drawhead. There is thus caused a great strain on this side of the drawhead, and especially on a section—*i.e.*, through the pivotal holes, which in the required constructions adapted to the conditions is the weakest portion of the drawhead, as increased strength by greater dimensions (except in depth) is not attainable under the restrictions of the contour lines required by the M. C. B. Association. The dimensions of the knuckle around the pivotal hole are also correspondingly restricted.

It will very quickly be discovered by any one undertaking the design of an M. C. B. coupler that the positions of the lock and pivotal point are mutually dependent one upon another, and that as the lock is moved over toward the center line and on to the other side of the drawhead, the pivotal point must be brought further back in the drawhead, so that the shank of the knuckle, when open, shall not project too far from the drawhead, and thus become jammed and prevent coupling. On the other hand, if the pivotal pin is moved back farther into the body of the drawhead, the lock must be placed nearer the center line, for otherwise the leverage on the lock would be greatly increased. The effect of this is clearly shown in fig. 6, which represents a design of a coupler at one time extensively used, but which has been abandoned.

Fig. 4 illustrates the construction whereby the pivotal pin is located farther back in the drawhead than in fig. 1, and in which less strain is developed at the pivotal pin. It allows a greater thickness of metal around the pivotal holes of the drawhead and knuckle, and has, therefore, a threefold advantage in securing a much stronger design, while at the same time the pulling force is partially transferred to the center of the drawhead.

In fig. 5, as above stated, a straight pulling force is directly and completely sustained by the lock, and the draft is entirely from this point. This construction, however, while it relieves the pivotal pin and transfers the force to the center of the drawhead, causes an increased strain in the shank of the knuckle, to withstand which a great weight of metal would be required.

Fig. 7 shows another form in which the pivotal pin and lock are respectively on opposite sides of the center or line of draft. The pulling force in this construction acts on both sides of the drawhead, and the distribution is dependent upon the distance which the lock is from the center line and the angle which the bearing face of the lock makes with this line. The pivotal pin is placed back in the lugs to the extreme limit permissible for proper action of the coupler, and there is thus secured the greatest possible thickness of metal for the lugs of the drawhead, the pivotal pin, and around the pivotal hole in the knuckle. This, together with reduced strains produced by the pulling force, constitute great advantages of this construction over any so far considered.

Thus far the action of pulling forces have been chiefly referred to. It is, however, the buffing forces which cause the severest strains to which a coupler of this type is ever subjected, and undoubtedly effects the larger proportion of the breakage which occurs. It is generally a shock, and the most difficult, for the metal to withstand.

Referring again to figs. 1 and 5, it will readily be seen that the strain caused by a buffing force, and sustained by the pivotal pin decreases (*a*) as the angle between the surface of resistance in the drawhead and the line of action of the buffing force becomes greater also ; (*b*) as the surface of resistance approaches nearer the line of action of the buffing force, and that it will be a minimum when the center point of the surface of resistance is exactly on the line of action of the buffing force, and the direction of this line is at right angles to the surface. Thus in figs. 1 and 5 the force acting on the pivotal pin is represented by *I S*. The consequent tendency of this force to break off the pivotal lugs of the drawhead is in the former case much greater than in the latter ; therefore, considering both effects of the pulling and buffing forces, the construction shown in fig. 4 (the buffing resisting surface being in the same position as in fig. 5) would appear to possess an evident advantage as regards strength and resisting power over either those of figs. 1 or 5.

Proceeding to the case illustrated in fig. 7, we have the lock moved over the center line to the side opposite that in which is located the pivotal pin, and the buffing surface central on the line of buffing force. The parallelogram of forces shows that the sum of the forces sustained by the lock and the pivotal pin is greatly reduced, and that by a proper direction of the bearing surface of the lock these forces may be equalized. The force acting on the lock is no greater than that which occurs in the construction represented by either figs. 1 or 4, and the force on the pivotal pin is much less. The pulling force is, besides, more equally distributed over the knuckle and drawhead, and the *sum* of the forces acting on the lock and pivotal pin is made to very nearly equal the pulling force ; that is, *it closely approaches the minimum*, which is only attainable when the locking surface is placed perpendicular to the line of action of the pulling force. But to maintain an equal distribution of force at the same time, at the lock and pivotal pin, this latter condition necessitates the lock and pivotal pin being equally distant from the line of action of the pulling force, and this is impracticable of application. The buffing force is resisted at a surface within the drawhead on the line of action of the force and at right angles thereto, so that, as before explained, no strain is caused at the pivotal pin. Hence the condition of *minimum total* strain on the knuckle and drawhead is here again attained in the case of a buffing force as it was for a pulling force, for it at all times equals and never exceeds the buffing force itself. It is apparent that the necessary form of knuckle may be made to withstand an immense compressive force, and that this quality together with the advantages of increased dimension for the pivotal pin and the reduced strain at the lock and pivotal pin for both buffing and pulling force, especially the former, combine to constitute a construction of superior strength and endurance.

This latter property in its relation to construction it is now proposed to examine.

The durability of a coupler, by which is meant the length of time during which it may be in use without becoming disabled from breakage or wear, is dependent upon two things : first, the material of which the coupler is made, and second, the construction or design.

The selection of a proper material is of the first importance, and is a subject which has been given considerable attention by both manufacturers and users of automatic couplers, but its discussion in reference to any coupler is applicable to all the various types and modifications, and is not within the scope of this article.

Construction in its relation to strength has already been considered, and it now remains to show how construction alone modifies the effects of wear.

Two M. C. B. couplers, when coupled together and locked, cannot come apart in a horizontal direction so long as the lateral movement of the entire coupler or knuckle alone is so limited by the heel of the knuckle of one coupler striking against the guard arm of the other that the coupling faces of the knuckles are kept in contact by a pulling force. If, however, this limit is exceeded, uncoupling takes place.

Now the lateral movement increases with the wear on the heel of the knuckle or guard arm of drawhead or both, and also in proportion as the coupling face of either of the knuckles moves outward from its respective drawhead. But for the same contour lines the effect produced by equal wear on either the knuckle or guard arm is the same in all forms of the M. C. B. coupler. It can not be modified simply by construction ; and as it is relative and not actual results which are sought, it will be omitted in the present

discussion.* The outward movement of the coupling face is the result of wear at each or all of three points—viz., the coupling face itself, the bearing face of the lock † and the pivotal pin or bearing. Again the effect of wear at the coupling face of the knuckle is the same in all forms of the stated coupler, and is in no way modified by construction, consequently, for the reason just given, it will also be neglected.

There remains, therefore, for consideration the effect of wear at the lock and the pivotal pin and its bearings, and it will be shown that at either of these points it is directly dependent upon the design or construction of the coupler, and varies in amount and in effect according to the relative positions of the lock, the pivotal point, and the line of action of the pulling force.

The wear at either point is proportional to the force acting at the point and inversely proportional to the wearing surface, and it is in the direction of that force. The effect of wear at either point in all cases is to cause the outward movement of the coupling face of the knuckle, but the amount and direction of this movement are dependent upon the relative positions of the lock and pivotal point, as will be subsequently shown.

By inspection of the diagrams already referred to, it will be seen that in fig. 1 there is the condition for greatest probable wear at the pivotal pin, while in fig. 5 there exists the condition for greatest probable wear at the lock, and in fig. 7 the total of the probable wear at the pivotal pin and the lock is very nearly reduced to the minimum.

It is evident that the outward movement of the coupling face of the knuckle caused by wear at the lock is, in each case, inversely proportional to the distance of the lock from the pivotal pin of the knuckle ; but this outward movement caused by the wear at the pivotal pin varies with the position and direction of the bearing face of the lock relative to the pivotal pin and line of draught, and is different in every case. The action may be shown by diagram.

Take, for example, the case as represented in fig. 1, and let fig. 2 represent an exaggerated wear at the pivotal pin. This wear is in the direction of the line *A O*. The first effect of a pulling force is to bring the knuckle into the position shown in fig. 2 ; that is, the knuckle is made to move outward in the direction of the line *A O* a distance equal to the wear *O O'* at the pivotal pin, so that the shank is drawn away from the bearing face of the lock the same distance. The second effect is to draw the coupling face still further outward until the shank of the knuckle is brought in contact with the lock ; and the final position taken by the knuckle is that indicated by dotted lines in fig. 3, the normal or first position being shown by full lines.

In the instance as shown by fig. 4, wear at the pivotal pin is developed as in the previous case in the line *A O*, but the bearing face of the lock is parallel to the line of action of the force acting on the pivotal pin, consequently a pulling force simply causes the knuckle to move outward and backward in that direction ; and the shank of the knuckle thus moves along and not away from the bearing face of the lock as it does in fig 1. It follows that for an equal wear at the pivotal pin there is less outward movement of the coupling face of the knuckle.

In fig. 7 the outward movement of the coupling face of the knuckle is still further reduced for equal wear, for as the direction of the wear at the pivotal pin corresponds with the direction of the line *A O*, the first effect of a pulling force is that represented by fig. 8, and the final position of the knuckle is shown by dotted lines in fig. 9, where the full lines represent the normal position. In this case the shank of the knuckle, instead of being drawn away from the bearing face of the knuckle, is forced up against it and held so that by this action the coupling face of the knuckle is thrown forward relative to its first or normal position.

It is further obvious that in this latter construction a wear at the pivotal pin has the effect of causing a draft strain at the coupling face of the knuckle to draw this end of the knuckle toward the horn or guard side of the draw-head and in a direction away from the pivotal pin, so that it not only projects beyond the normal position but also becomes more inwardly inclined.

(TO BE CONTINUED.)

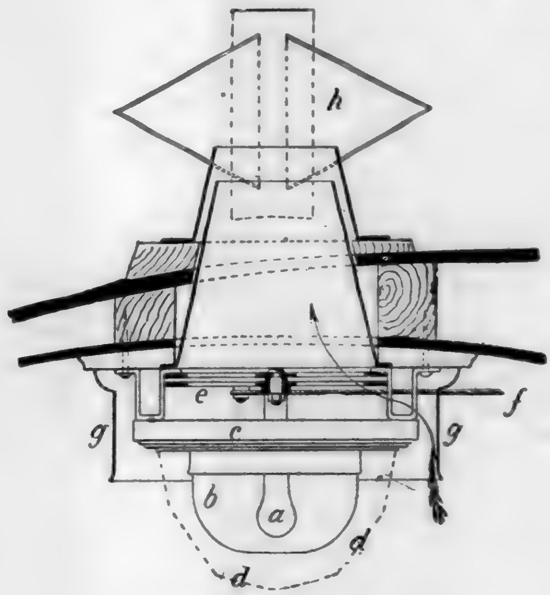
* Wear may, of course, be greatly reduced by case hardening or by similar means, and also by eccentrically attaching the coupler to the car so that a pulling force will have the effect of causing the two couplers to approach each other in a lateral direction, or, as it were, hug together and thus force the knuckle of one away from the guard-arm of the other.

† Any other wear on the lock will be small in comparison with that which takes place at the bearing face, and will not be considered.

ELECTRIC LIGHTING OF CARS.

THE Jura-Simplon Railroad Company, in Switzerland, has for some time been trying the lighting of its passenger cars by electricity, with so much success that a number of additional cars are to be fitted with electric lights, and that light will be used in all new cars built for the line.

The plan adopted by this company, as described in the *Revue Internationale de l'Electricité*, is the storage battery system. The batteries used are made by the Société Suisse, at Marly, and are, it is believed, of the lightest type yet devised. They are carried in a case placed under the floor of the car, each car being entirely independent so far as lighting is concerned ; they can be removed and replaced entirely from the outside. The box or case for the batteries used in the ordinary six-wheel cars of the road is 15.4 × 29.2 in. in size and 19.3 in. deep, and the weight of the batteries is 245 lbs. These cars have three lights of 10 candle-power each and two of 8 candle-power each, besides a 5 candle-power light on each platform. This makes a total of 56 candle-power, and the batteries used will keep the lights burning for 13 hours without renewal. In the cars used in the through international traffic lights of 70 candle power are provided, and in these cars a heavier battery is used, which will last for 20 hours' continuous lighting.



ELECTRIC LIGHT FOR CARS.

The lights are placed in the roof of the car, generally directly under the ventilators ; one of them is shown in the accompanying cut. In this *a* is the incandescent light ; *b*, the glass globe surrounding it ; *c*, the top and reflector ; *d* the shade ; *e*, the disc of the ventilator ; *f*, the arrangement for opening or closing the ventilator ; *g*, the frame ; *h*, the ventilator chimney.

The wiring of the cars has been carefully done in order to secure the best possible insulation. Some trials have been made of an arrangement by which passengers can regulate the light, but the results have not been favorable.

So far as it has gone, the results have been favorable,

but the light provided is hardly sufficient ; the substitution of lamps of 16 candle-power for those of 10 and 8 is recommended ; but in that case the weight of the storage batteries must be considerably increased.

DETERIORATION OF CONDENSER TUBES.

A WASHINGTON correspondent of the New York *Times* reports a curious phenomenon which has developed on board the cruiser *Baltimore*. That writer says :

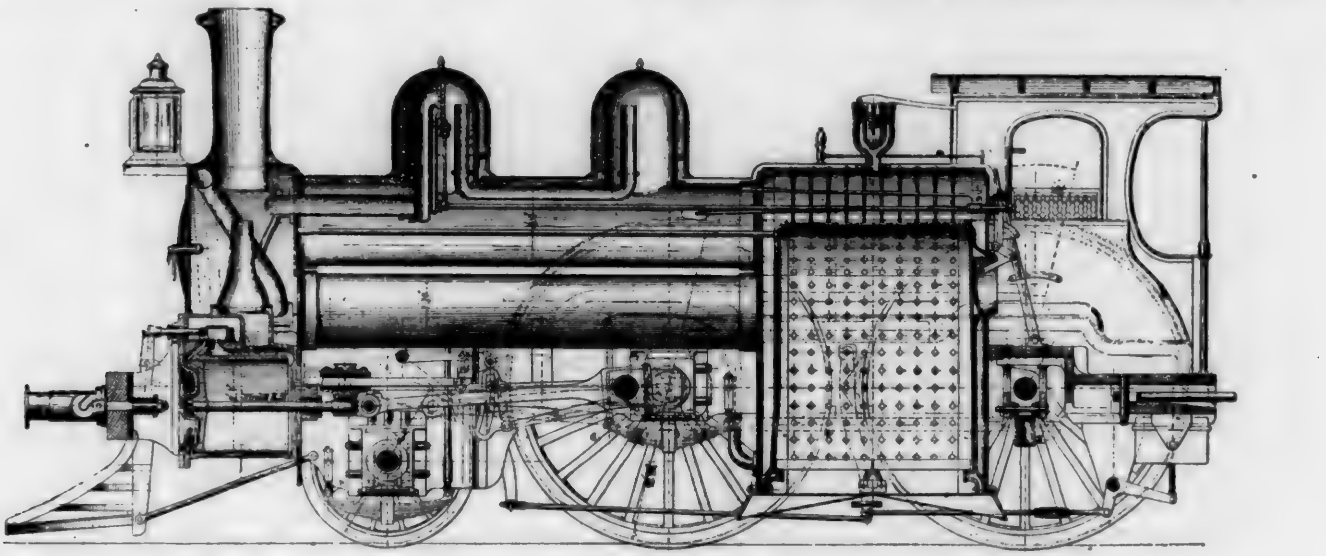


Fig. 1.—Sectional Elevation of Engine.

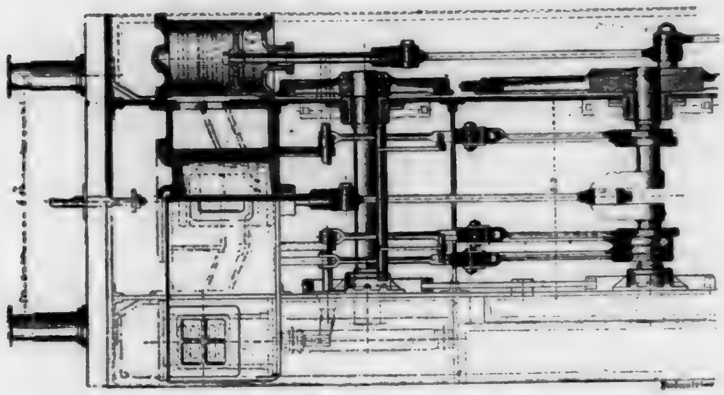


Fig 2.—Part Sectional Plan

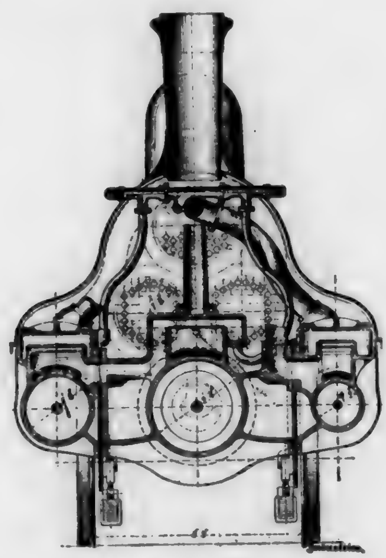


Fig. 3.—Transverse Section.

DESIGN FOR A TRIPLE-EXPANSION LOCOMOTIVE.

The deterioration of the condenser tubes of the cruiser *Baltimore*, with the necessity of replacing the entire lot, has called the attention of the Bureau of Steam Engineering in the Navy Department to a phenomenon which is certainly curious, and for which there has not thus far been an explanation advanced which has received general acceptance, or which is even entirely plausible.

The *Baltimore's* condenser is of English design, and carries out the English naval practice of having the steam inside of the tubes and the refrigerating water outside. Owing to a variety of causes, the space around one of these tubes became almost solid with mud, and when the vessel arrived at Mare Island recently, advantage was taken of the opportunity to remove the tubes and thoroughly clean out the condenser.

On removing the tubes there was nothing in their appearance to indicate that there was anything wrong with them, but it was found that a very light blow would break them across. This led to a careful examination, and it was found that all the tubes were in this condition. They could be broken across the knee as easily as a small stick. The fracture showed a complete change in the material. A thin ring on the inside had the color and appearance of the brass of which the tubes were originally composed, but outside of this the rest of the tube was of a dull copper color, without metallic luster, and giving the impression of fine particles of some material deposited from a solution.

The whole phenomenon was so entirely different from the usual experience with condenser tubes, which have generally been considered indestructible when intelligently treated, that an explanation seemed impossible. One theory was that the deterioration was caused by having the steam inside of the tubes instead of outside, as has always been the custom in the United States Navy ; but no such occurrence has been reported with English condensers built in this way ; and inquiry brought out the fact that a condenser of this pattern, in an American merchant vessel, had tubes which, after fourteen years of service, were as good as when put in.

Another theory was that, as no such trouble had ever been encountered while the shells of the condensers were of cast iron, the deterioration was consequent upon the use of brass condenser shells, the idea being that the tubes and the shell were sufficiently far apart on the electrical scale to form a battery in which the tubes were the positive pole and were attached, the zinc in them being dissolved out. This theory would seem quite plausible were it not for the fact that on the *Baltimore* and some other ships copper pipes connected with the condenser have also shown marked deterioration.

As far as can be learned, there has been trouble on nearly all the new ships with the copper pipes ; and this is not confined to the American Navy, but the English have

had the same trouble. A correct explanation will be of great interest to all mechanical engineers. A chemical analysis of some of the defective tubes of the *Baltimore* is now in progress, and when it is completed, it may throw some light on the subject.

A TRIPLE-EXPANSION LOCOMOTIVE.

THE accompanying illustrations, from *Industries*, show a triple-expansion locomotive which has been designed for the Northwestern Railroad of Beloochistan by the Engineer of the road, Mr. John Riekie. The road is of 5-ft. 6-in. gauge, and is, we believe, an extension of the Northwestern of India.

The boiler, it will be seen, is of peculiar construction. The fire-box is of the ordinary shape, but the barrel consists of three separate cylinders connected to the outer fire-box casing at the rear end, and to the smoke-box at the front. The upper one of the three is 24 in. in diameter and is about half full of tubes; the two lower ones are 21 in. in diameter and are filled with tubes. There are 130 tubes altogether, 1¾ in. in diameter, 52 in each of the lower cylinders and 26 in the upper one. The fire-box is 62 × 49¼ in. inside.

The engine is carried on four coupled wheels 7 ft. 11⅛ in. in diameter and one pair of leading wheels 4 ft. 3 in. in diameter. The total wheel-base is 16 ft. 2 in.

There are three cylinders arranged as shown, the high-pressure outside on one side, the intermediate on the other, and the low-pressure in the center; the latter is connected to a crank in the main driving-axle. The steam pipes connecting the cylinders are apparently intended to act as receivers. A special pipe and valve are provided, by which steam can be admitted at boiler pressure to both the high pressure and intermediate cylinders at once, for use in starting a train. The valve motion is of the hanging link type, and each cylinder has its own separate eccentrics, links, etc., as shown.

The cylinders are 14 in., 20 in., and 28 in. in diameter and 26-in. stroke, the ratio of the high-pressure cylinder to the others being 1 : 2.04 : 4.00.

It is not stated whether this locomotive is under construction, or whether it is still simply a design. The boiler pressure at which it is to work is not given.

RUSSIAN RAILROADS IN ASIA.

THE Technical Commission, to which was entrusted the duty of deciding on the final location of the Trans-Siberian Railroad, has decided in favor of the line which was described by our Russian correspondent in the articles published in the JOURNAL some time ago.* This line starts from Zlatooust, the present terminus of the Samara-Oufa line, and will pass through Omsk, Nijni-Udinsk, Irkoutsk, Krasnoiarsk, and around the southern end of Lake Baikal to the upper waters of the Amour, and will then follow that river and its chief southern affluent, the Oussouri, to Grafskaia, whence it will run nearly due south to Vladivostok. The total length is about 4,900 miles, but nearly one-third of this is covered by river navigation, which can be used to supplement the sections of the railroad as they are built.

The western section, from Zlatooust to Omsk, traverses the best cultivated and most thickly inhabited parts of Siberia, and with a branch to Tomsk, and connections with river navigation on the Obi and the Irtish, may be expected to develop a considerable business. The central section, from Omsk to Irkoutsk, is through a rough and thinly peopled region, and but little traffic can be expected from it unless the building of the road leads to the development of its mineral resources.

A branch which will doubtless be built from some point near the southern end of Lake Baikal to Kiakhta will bring to the road the very considerable trade with China, which is all done through Kiakhta, and is now carried in the winter by caravans of freight sledges.

On the western end the Samara-Oufa line, which is the connecting link with the railroad system of European Russia, is now being extended from Zlatooust, its present terminus, a distance of 115 miles to Miask, which is the center of the gold mines of the Eastern Oural. The beginning of work on the road from Vladivostok on the Pacific to Grafskaia on the Oussouri has already been noted.

It may be added that the engineers are now making a careful study of the more important river crossings. At several of those car ferries will be established, to be replaced by bridges after the railroad is completed. Some of the bridges on the Siberian Railroad will rank among the great engineering works of the world; notably the crossings of the Tom, the Tobol, the Obi and the Irtish; and the whole line is the most important railroad work now in progress anywhere in the world.

THE Russian Trans-Caspian Railroad, which was originally a purely military line, is developing gradually a commercial business of considerable amount. The caravan traffic which passed through Bokhara and Merv has gone to the railroad, and already some local business has sprung up from the Russian settlements. General Annenkoff, who built the road, and who is an engineer of no ordinary ability, saw that the settlement of the country depended entirely upon irrigation, and the works planned by him are now being carried out. The Galodnaia Steppe is already receiving water from the Sir-Daria, and work has been begun on a canal which will carry the waters of the Oxus to Bokhara and restore the ancient fertility of the country around the old Tartar city. Some irrigation works on the imperial domain of Bairam-Ali are nearly completed. The country around Pendjeh is also to be irrigated, and water will be brought from the Zarafshan and the Tchirtchick to Tashkent and Samarcand. Works of the same kind for the oasis about Askhabad are designed, but not yet begun. In fact, the improvements there and at Sarakhi, which General Annenkoff planned, will not be carried out until the sources of the water supply in the mountains of Khorassan are brought fully under Russian control.

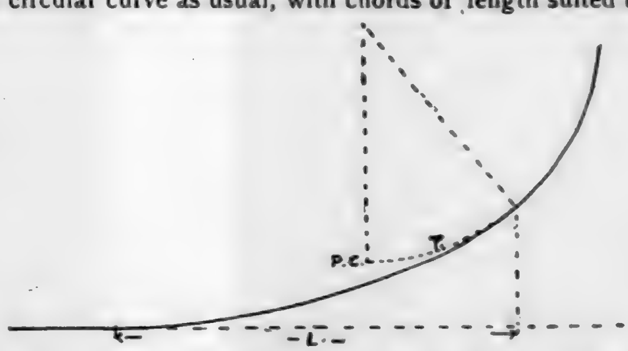
The Merv oasis, it is now believed, cannot be reclaimed to any extent, owing to want of water; and the town of Merv will have to depend, not upon the surrounding country, but upon its importance as a trading post and as a strategic point in the event of operations against Afghanistan and India.

A SHORT RULE FOR TRANSITION CURVES.

THE following short rule for laying out these curves is submitted by Mr. J. F. Ward, who claims that it is practical, easy and sufficiently correct for general use:

TRANSITION CURVES.

Offset *P C* as desired to any extent, and run in the points of circular curve as usual, with chords of length suited to



the curvature; then measure from *P C* along the curve to any point where you wish to connect the transition curve, and call the distance *T*.

Measure the ordinate from this point to the tangent, and call the length *O*.

Find D = the degree of curvature of the circular curve, then $\frac{O \times 17.000}{D\ T} = L$, the length of the transition curve measured on the tangent.

Having L and O given, calculate the intermediate ordinates as proportional to the cubes of their abscissæ.

* See the RAILROAD AND ENGINEERING JOURNAL for June, September, November and December, 1890, January, February, March and July, 1891.

ENGLISH SALOON CARS.

In a recent paper published in *Glaser's Annalen*, Herr Büte describes a number of the special saloon or drawing-room cars on English railroads. Those given herewith, like nearly all the others, are special cars intended for the use of distinguished persons.

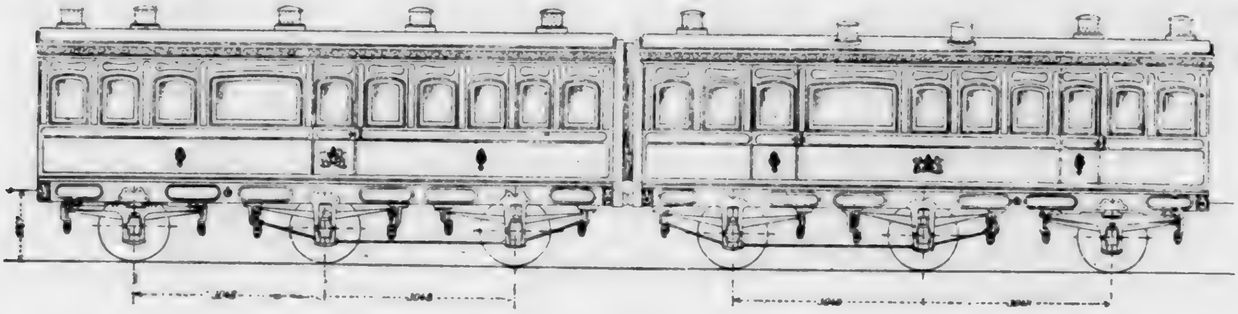


Fig. 1.

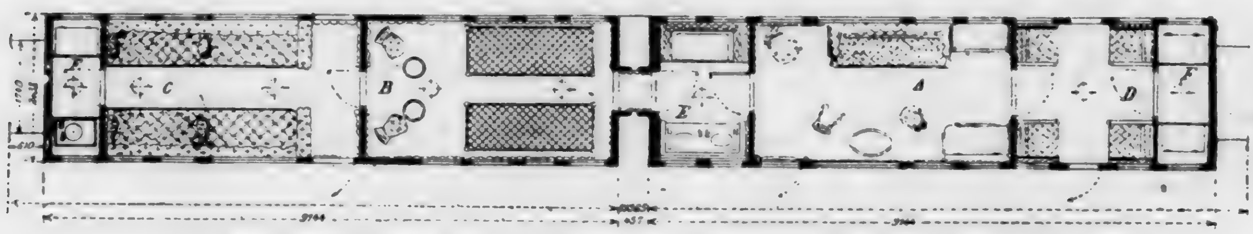


Fig. 2.

ROYAL SALOON CAR, LONDON & NORTHWESTERN RAILWAY.

Figs. 1 and 2 show an elevation and plan of the cars constructed for the use of the Queen, on the London & Northwestern Railroad. These are, it will be seen, two six-wheeled carriages, with a sort of vestibule arrangement which makes them practically one when in use. Each of the cars is 30 ft. long over all and 7 ft. wide.

In the plan *A* is a day saloon or sitting-room, having a door on each side; *B* is the bedroom or night saloon, provided with two beds or couches; *C* is a saloon for the ladies-in waiting, which also has a door on each side; *D* is a compartment for servants, also provided with outer doors; *E* is the Queen's toilet-room; *F F* are toilet-rooms for the attendants. The cars are of the construction usually adopted for English passenger coaches, the underframe being of iron; the car-body is of oak, pine and teak, and the finish is in mahogany.

Figs. 3 and 4 show a car lately built for the Queen at the Great Western Railroad shops at Swindon. This car is 43 ft. long and 8 ft. 10 in. wide; it is carried on two four-wheeled trucks. Unlike the first one shown, it has no sleeping-room, being intended for short journeys only.

In the plan, fig. 4, *A* is the entrance passage, with a door at each end; *B* is the main saloon, provided with a sofa, chairs and a table; *C* is a room for attendants, having a door at each side and a toilet-room, *D*, opening into it; *E* is a private toilet-room opening from the main saloon; *F* is another room for attendants, also provided with outside doors and a toilet-room, *G*.

It will be noticed that this car is a little wider and higher in the middle than at the ends. The main saloon is 15 ft. 9 in. × 8 ft. 4 in. inside. This car also has an iron under-frame and wooden body.

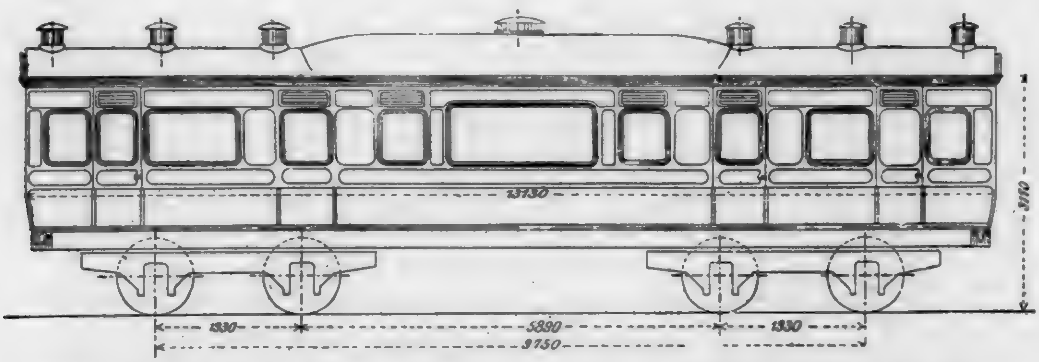


Fig. 3.

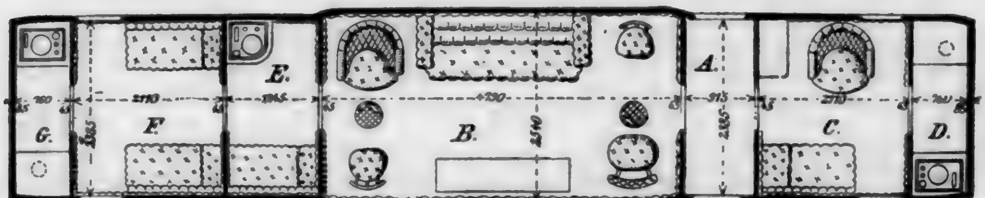


Fig. 4.

ROYAL SALOON CAR, GREAT WESTERN RAILWAY.

Other saloon cars differ from those described chiefly in having seats for a greater number of persons provided, and in their finish, which is somewhat plainer.

STRENGTH OF PINE TIMBER.

Some reference has heretofore been made to the important timber tests which the Forestry Division of the Department of Agriculture is now conducting. The circular given below shows the results of one of these tests:

Among the investigations of timber which for the last six months have been carried on by the Forestry Division,

as described in Circular No. 7, one series of tests was instituted to determine the effect which the practice of gathering resinous matter for the manufacture of turpentine and naval stores from the longleaf pine of the South may have upon the strength of the timber of trees subjected to this practice.

The gathering of resin is done by cutting a recess (box) into the foot of the tree, which is called "boxing" the tree, and then scarring (chipping) the trunk above the box, increasing the size of the scar from year to year. From this scar the semi-liquid resin exudates and drains into the box; this process is continued for four years, and then the trees, lessening in yield, are abandoned.

The current public belief has been that the timber of these "boxed" trees, sometimes called "turpentine timber," is deteriorated by the process. Not only is its durability, in which this species excels, believed to be lessened, but also its strength, and hence its value in the market has been considerably reduced.

Since annually from 500,000 to 750,000 acres of this pine are boxed, involving in this assumed deterioration, at the lowest estimate, 1,000,000,000 ft., B. M., of lumber, a considerable loss in values, counting by millions of dollars, is thereby incurred.

As far as durability is concerned, there seems little doubt that the withdrawal of the resinous matter, which furnishes protection against the penetration of water and seems also to have antiseptic properties, reduces the capacity to withstand rot at least in some parts of the tree; the portion near the scar, where the resin accumulates, of course becomes more durable. But it did not seem reasonable that the strength in general should suffer. The tests conducted in the test laboratory at St. Louis, in charge of Professor J. B. Johnson, give countenance to the important conclusion, that "*turpentine*" *timber seems to possess greater strength than timber from unboxed trees.*

Although the tests and examinations of this series are not yet completed, and further study will perhaps necessitate modifications of this general statement, the economic importance of the discovery seemed to call for immediate preliminary publication, especially since the investigation had to be interrupted for lack of funds and may, therefore, not be continued for some time, delaying verification and fuller conclusions.

The mean of 115 tests of boxed timber, and of 133 tests of unboxed timber shows the following results:

	Boxed Timber.	Unboxed Timber.
Tensile strength.............	15,485 lbs. per sq. in.	16,429 lbs. per sq. in.
Compressive strength endwise	6,935 lbs. per sq. in.	5,661 lbs. per sq. in.
Cross-breaking strength.....	11,118 lbs. per sq. in.	9,333 lbs. per sq. in.
Modulus of elasticity........	1,694,000 lbs. per sq. in.	1,800,000 lbs. per sq. in.
Elastic resilience..........	2.76 lbs. per cu. in.	1.92 lbs. per cu. in.
C'mpr'ssive str'gth acr'ss g'n	1,122 lbs. per sq. in.	855 lbs. per sq. in.
Shearing strength....... ...	636 lbs. per sq. in.	652 lbs. per sq. in.

A detailed account of the experiment will be published later, when tests and examinations are fully completed. It is here intended only to give the basis upon which the above conclusion is stated.

The test material was collected at Wilson's Station, Alabama, consisting of eight trees which had been boxed and abandoned five years, and 11 trees which had been worked for the last time during the past season. These trees furnished, besides some 50 disks for physical examination, 20 logs for tests. From these 115 test pieces for each kind of test were prepared. For comparison 40 logs from 11 unboxed trees, collected at Wallace and Thomasville, Alabama, furnished 133 test pieces for each kind of test.

It having been established as a law that strength changes with the amount of seasoning, it became necessary to establish the ratio of change due to seasoning in the boxed timber (which had been tested green), by special tests on 25 sticks taken from corresponding positions in the tree which were seasoned. Then the tests on all the green sticks were corrected for 20 per cent. moisture, corresponding to the moisture percentage of the unboxed timber. The results are exhibited in condensed form in the accompanying table.

Since among the unboxed specimens there were quite a number from higher positions in the tree than those of the boxed specimens, which were mainly taken at a height of 7 to 33 ft. above ground, a selection was made of the results of 15 tests made on sticks of nearly like position and diameter of tree, both boxed and unboxed. In this comparison the numerical value of the difference is naturally reduced, but not the general tendency, namely, to show that "turpentine" timber, while exhibiting less tensile and shearing strength, is tougher than that from unboxed trees, and has greater compressive and cross-breaking strength. At the same time it may be stated that turpentine timber proved itself harder to work, the resin collecting in spots gumming up the tools.

The possibility of flaws in experiments of this kind makes it proper to caution against full acceptance of the results until further verified. Especially is it desirable to extend the investigations into the higher portions of the tree, for while no deterioration seems to take place near the scar of the tree, perhaps because the resinous juices are drained in that direction, it is possible that the wood of the higher portions of the tree may be changed, either for worse or for better. There has not been time yet to study the physical changes which have taken place in the different parts of the tree due to the boxing.

We feel, however, justified to maintain that the claimed inferiority of turpentine timber in strength does not exist.

Information regarding authenticated cases of practical observation on this point is solicited by the Division.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 135.*)

Realizing the utter insufficiency of man power, or of any known primary motor, some inventors have designed flying screws to be worked by new-fangled motors. Of these was the apparatus of *Pomès & de la Pauze*, proposed in 1871, and shown in fig. 30. The sustaining screw

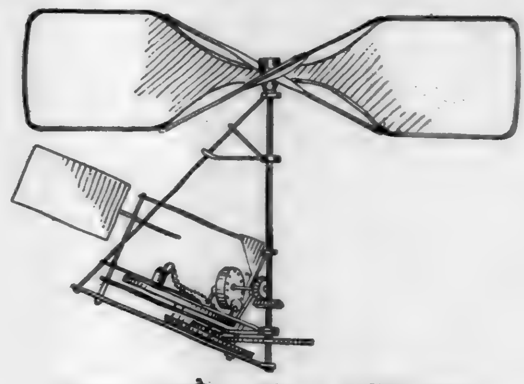


Fig. 30.—POMÈS & DE LA PAUZE—1871.

was inclined so as to obtain an oblique ascent, and appears to have been adjustable. The steering was to be done by a rudder, and the whole was to be worked by a gunpowder motor. The first requisite, therefore, was to perfect the gunpowder engine. It is not known how much was accomplished toward this; but the flying apparatus was never built.

The next year (1872) M. *Renoir*, a member of the French Society, proposed an apparatus consisting of two aerial screws placed side by side in the same horizontal plane, but with shafts capable of being moved out of the vertical, in order to secure movement in both directions. They were to be driven by steam, and to rotate in opposite directions; and M. *Renoir* computed that the axis of rotation would have to be inclined 11° in order to obtain a horizontal course. Also, that to produce satisfactory forward speed, the additional power required would be but 10 per cent. of that required for sustaining the weight. Aside from the main question of the motor, which was left in abeyance, the important thing to ascertain was the best form of sustaining screw, in order to get the

utmost support with the least expenditure of power; so the succeeding year, M. *Renoir*, having studied the results obtained by M. *Pillet* with a concave screw* in a series of experiments beginning in 1848, tried some experiments of his own with a screw provided with a return flange or turned edge, to prevent the centrifugal escape of the air, of which he gave an account in the *Aéronaute* for April, 1873.

He drove his screw by man power, and claimed that the results showed that a force of one horse power could sustain, by means of his screw, a weight of 165 lbs.; but Mr. *Bennet*, in giving an account of these experiments to the Aeronautical Society of Great Britain, in 1874, gave a somewhat different account, and said:

> Two years ago M. *Renoir*, a member of the French Society, experimented with a screw 15 ft. in diameter, with which, by the action of his feet, he was able to lift a weight of 26 lbs. The screw was two bladed, with an increasing pitch, the angle of inclination being 3° at the front edge of the blade and increasing to 30° at the back edge. The two blades cover the entire area of the screw, and have a deep rim suspended from them to prevent the air being driven from the circumference by centrifugal force. M. *Renoir* estimated the power he developed was about one fifth of a horse power; but this was considered by the members of the French Society present at the experiment to be considerably below the real power exerted. As the screw was driven by the feet, after the manner of a velocipede, the body being in a good position for exerting its maximum effort, the power developed was undoubtedly nearly one horse power. A man running up a pair of stairs is able for a few seconds to exert two horse power, and mounting a ladder placed vertically, by the help of his hands, an ordinary man can do the work of 1¼ horse power. These facts have been determined by experiment.

While on the subject of the form of screws, it may be well to call the attention of those who may desire to study the subject further to an article upon "Propulsors," by M. *Crocé Spinelli* (the same gentleman who lost his life in the scientific balloon ascension of the *Zenith*), which will be found in the *Aéronaute* for April, 1870, and to another by the same author on "A Screw with Variable Pitch" in the *Aéronaute* for November, 1871. Also to the remarks on screws by Mr. *Wenham* in the first and second reports of the Aeronautical Society of Great Britain, and to those of Mr. *Thomas Moy*, in the fourth report of the same society. He evidently knew what he was talking about.

In 1872 Mr. *Wenham* proposed a method for varying the pitch of the screw, which may be found in the report of the British Aeronautical Society of that year. The blades were to be made of some fabric, one edge being attached to a cross arm, which was made fast to the shaft of the screw. The other edge of the fabric was fastened to another cross arm, so arranged as to be placed in any position on the shaft, and firmly fixed in such position. A coiled spring was to keep the two cross arms apart, and thus maintain the fabric tightly stretched. If the adjustable arm be placed precisely in line with the fixed arm, then the blade is parallel with the shaft, and by moving

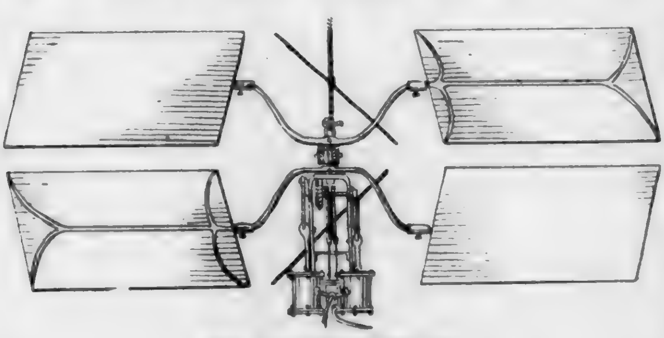


FIG. 31.—DIEUAIDE—1877.

the adjustable arm to one side more or less, the pitch can be made anything desired.

The next experiments on screws were tried in 1877, by M. *Dieuaide*, formerly Secretary of the French Aeronautical Society, and the well-known Engineer and Patent Attorney, whose clever *chart* has furnished (by permission) almost all the illustrations contained in these articles. His apparatus is shown in fig. 31. It consisted of two pairs of square vanes set at various angles to the line of motion, so as to vary the pitch, and rotated in contrary directions by gearing. The power was furnished by a double cylinder steam-engine connected with the boiler by a flexible hose, and the lifting power of the screws could be accurately weighed by simply putting the apparatus on a scale.

The results of the experiments seemed to show "that this double screw could not, in consequence of the losses of power due to the gearing, exert a lifting force greater than that of 26.4 lbs. per horse power." This agrees closely with the results of the experiments of *Giffard* with a single screw; he having found that 6 horse power would lift with a screw 165 lbs. at the rate of 3.28 ft. per second, or say 27.5 lbs. per horse power, from which he deduced the conclusion that the aerial screw gave out but 18 per cent. of the power exerted to drive it.

The next apparatus to be noticed was not experimented with, so far as the writer has ascertained, but was a proposal of great oddity and originality patented in 1877 by M. *Mélikoff*, Engineer and graduate of the school of the "Ponts-et-Chaussées." It is shown in fig. 32, and consisted in a sort of screw parachute composed of "two hyperbolic paraboloids united by their concavities into a

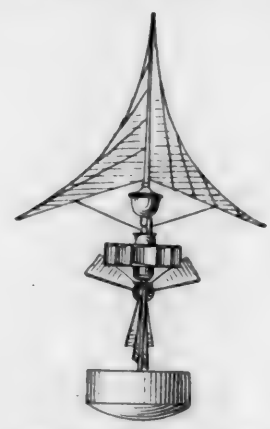


FIG. 32.—MÉLIKOFF—1877.

sort of cone or pyramid with a rectangular base in projection." This was to be furnished with a series of zones, shown in section in the figure, to act upon the air; and this arrangement, the one resembling a spear-head in the figure, was expected to screw itself up into the air and to act as a parachute in coming down. It was to be rotated by a gas turbine, consisting of eight curved chambers, into each of which charges of the vapor of ether mixed with air were to be successively exploded by an electric spark, and the charges allowed to expand in doing work. The surfaces were to be kept cool by melting ice and by heating the resulting water. This ice and the supply of ether were to be carried in the recipient shown just below the parachute, the turbine being shown lower down; this motor was expected to work also an ordinary screw with three arms, geared on a short axle, from which screw horizontal propulsion was expected. Below all is shown the car for the operator.

M. *Mélikoff* designed his apparatus to carry up one man, and estimated its total weight at 374 lbs. Of this the apparatus proper was to absorb 108 lbs., the gas turbine was to weigh 92 lbs., its supplies for one hour were to amount to 40 lbs., and the operator was to be of 134 lbs. weight. The rotating surface was to measure 87 sq. ft. in area, thus giving a proportion of 4.3 lbs. to the sq. ft., which seems entirely too small, although claimed to be calculated from the tables of air pressures given by *Thibault*. The turbine was to be of 4 horse power, being thus estimated to weigh 23 lbs. per horse power, and it was to consume per horse power per hour 3.3 lbs. of ether and 8.7 lbs. of ice for cooling the parts, thus showing a slight discrepancy from the aggregate of 40 lbs. of supplies estimated as required for one hour.

The apparatus as a whole is scarcely worth experiment-

* *Aéronaute*, March, 1870.

ing with, and has been chiefly described because of its oddity; but the weight and power of the projected gas turbine seem to have been worked out with some care, and it might be worth while to take the subject up again, in order to ascertain whether it is practicable to construct a rotary gas motor weighing as little as 23 lbs. to the horse power.

The next experiment to be noticed was tried by M. *Castel*, a mechanical engineer, in 1878. He wanted to determine the amount of mechanical work required to sustain a motor in the air, and built the apparatus shown in fig. 33. It consisted of eight double screws rotated in opposite directions by a double-cylinder compressed-air engine,

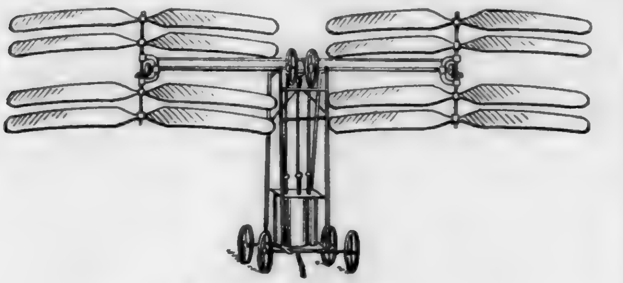


FIG. 33.—CASTEL—1878.

mounted upon wheels and fed with compressed air through a long, very light rubber hose. The weight of the whole apparatus was 49 lbs., of which 22 lbs. was in the screws and their machinery. The screws were 3 93 ft. in diameter, and weighed 1.32 lbs. each.

Experiments were repeatedly tried, but they came to an early ending by the apparatus rising upon the air, taking a sheer, and smashing itself against the wall of the room. M. *Castel* did not publish the results accomplished in the way of lifting a measured number of pounds per horse power developed; but he stated that he "no longer had the confidence which he once possessed in screws as future instruments of aviation. Elastic surfaces with an alternating action to impart vibratory motion to the air now seem preferable to screws to solve the problem of aerial navigation with an apparatus heavier than the air." He estimated from an examination of the muscles of birds and of the amount of work which those muscles were able to give out, that the bird in full flight expended not more than 24 foot-pounds per minute for each pound of his weight, so that a bird, if he weighed 220 lbs., would only expend a maximum of 0.16 horse power.

Now, we have already seen that the average power of a man is 0.13 horse power, and that although he weighs less than 220 lbs., he cannot fly with wings by his muscular efforts, so that the estimate must be erroneous.

M. *Castel* proposed to build a petroleum motor to drive his proposed wing apparatus, but he probably found himself unable to keep within the necessary limits of weight.

A simpler apparatus than M. *Castel's* accomplished much better results, for in the same year (1878) Professor *Forlanini*, an Italian civil engineer, launched into the air the second steam apparatus which has flown with its contained supply of steam; the first having been that of Mr. *Phillips*, already described. Fig. 34 shows the flying screw arrangement experimented with by M. *Forlanini*.

It is composed of two double-bladed screws, of which the lower one is rigidly fixed to the steam-engine, while the upper one rotates; the result being that the lower screw furnishes a fulcrum upon the air, while the upper one furnishes the ascending power. The whole apparatus thus slowly rotates upon its own axis; but this feature, which would be very objectionable in a really navigable apparatus, could be eliminated by rotating both screws in inverse directions.

The upper screw was worked by a double cylinder steam engine of ¼ horse power, supplied with steam from superheated water contained in a depending hollow globe after the manner of the well-known fireless locomotive, the initial pressure being some 120 to 160 lbs. per sq. in. It was the original design of M. *Forlanini* to send up his apparatus with a steam boiler attached, fired by 200 minute alcohol flames; but this proved too heavy to be lifted by the machine, and he substituted the hollow globe, tested to an internal pressure of 225 lbs. per sq. in., which, being two-thirds filled with water, is simply laid upon a fire until the desired pressure is obtained; when, on being withdrawn, the throttle-valve which admits steam to the cylinders is opened, and the apparatus rises.

It has been repeatedly tested, and its best performance seems to have been to rise to a height of 42 ft. and to remain 20 seconds in the air. M. *Forlanini* expressed the intention of following it up with an improved apparatus, of which he had the design, and with an engine of 2 horse power; but it is stated that he has not had the leisure to carry out this intention.

The total weight of the original apparatus was 7.7 lbs., and the aggregate area of the screws was 21.5 sq. ft., thus giving a bearing surface of about 2.8 sq. ft. per pound. The weight of the steam-engine proper was 3.52 lbs. and that of the screws 1.32 lbs. The hollow globe, charged with water, weighed 2.20 lbs., and the steam-gauge and connections weighed 0.44 lbs. more, leaving 0.22 lbs. for other accessories. It will be noticed that the engine, the boiler and the gauge weigh about 80 per cent. of the whole, which proportions could not be expected to obtain in a navigable apparatus; but, on the other hand, a larger steam-engine and boiler would weigh less in proportion to its power than the minute one thus experimented with, in which steam was very wastefully used in consequence of the relatively very large proportion of radiating surfaces.

M. *Forlanini* designed a self-generating steam boiler, which he expected to weigh but 13.2 lbs. per horse power; but it is not known to have been constructed.

This, then, is the best that has hitherto been done with steam. A model screw machine weighing 7.7 lbs. has risen 42 ft. into the air and flown for 20 seconds, but without taking up a self-generating steam boiler. The power

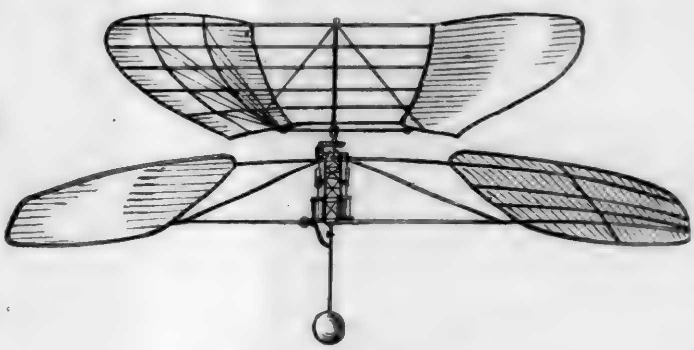


FIG. 34.—FORLANINI—1878.

developed ranged from 7,800 to 10,850 foot-pounds per minute, and the total weight sustained was at the rate of 26.4 lbs. per horse power.

Some time about the year 1880 Mr. *Edison*—the great Edison—at the instance of Mr. James Gordon Bennett, made some preliminary experiments to promote aerial navigation. He began very judiciously by trying to ascertain what could be done with the aerial screw as a propeller. For this purpose he is reported to have placed an electric motor of 10 (?) horse power, connected with a vertical shaft surmounted with rotating vanes upon a platform scale, and to have connected it by a wire with a source of electric power—the object being to ascertain how much the whole could be lightened by the action of the vanes upon the air.

He rigged upon the shaft first one kind of propeller, and then another, until he had tried all that he could think of; the best being a two-winged fan with long arms.

He is reported as saying that the best results obtained were to lighten the apparatus some four or five pounds of its total weight of 160 lbs., but the amount of power developed is not stated. This must have been quite small, and Mr. *Edison* must have been unfortunate in his selection of the screws to be tried, for we have seen, by the experiments of others, that a motor of 10 (if it was really this) horse power ought to lift 260 lbs. It is no wonder that he is reported as saying that "the thing never will

be practicable until an engine of 50 horse power can be devised to weigh about 40 lbs."

It is understood that somewhat similar experiments were tried by Mr. *Dudgeon*, the celebrated maker of hydraulic jacks. He tested the lifting effect of various forms of screws when rotated by steam power, and, like Mr. *Edison*, he stopped in disgust when he found how small was the lift in proportion to the power expended.

There may have been other experiments with lifting aerial screws in the United States, but they have not come to the knowledge of the writer. In point of fact, such aerial devices do not seem to have received much attention from inventors, and there have been but few patented proposals therefore in the United States.

In 1876 a patent was taken by Mr. *Ward*, of San Francisco, for an aerial vessel in which the supporting and the propelling power was to be furnished by a series of fan blowers. The fans furnishing the support were placed on horizontal shafts and the exhaust opened downward, so that the reaction would act against the force of gravity, while the fans which produced the horizontal motion were also arranged on horizontal shafts at the rear, the air being conducted to them through a duct from the front, and exhaust being to the rear, so that the reaction would force the vessel forward.

In 1877 Mr. *Ward* took out further patents, in which the apparatus was somewhat modified, but the general principles remained the same. It is believed that he tried some experiments; but no record of them has been met with by the writer, and a letter to the inventor has remained unanswered.

The same idea, but in a modified form, has quite lately (1892) been patented by Mr. *Walker*, of Texas; and perhaps experiments will be tried to test the lifting effect of air blasts under favorable circumstances; but as the efficiency of a screw, when used as a fan, is stated at only 35 per cent., while its efficiency as a propeller is stated at 70 per cent., it seems a question whether air blasts can be advantageously used in aerial navigation.

It may be pointed out here that there is a considerable difference between the fan blower and the screw propeller —a difference which should be more thoroughly understood by inventors. The most efficient fan blower is a machine which will produce the strongest current of air with any given expenditure of power. The best screw propeller is the machine which will produce the least current. If a screw propeller could be so arranged that it would not put the air in motion at all, then there would be no "slip," and the machine would be as efficient as a locomotive running on a dry rail, in which case all the power is expended upon the vehicle. In the case of a fan blower, or in the case of a steamboat moored to the wharf, and with its engines in operation, all of the power is expended in moving the fluid. It is all wasted in slip. In the case of the steamboat advancing through the surrounding fluid, or of the aerial machine, if it ever gets under way, a part of the power is expended in putting the craft in motion and another part in putting the fluid in motion, and the latter power is inefficient; it is the "slip." The best screw, therefore, is the one which shall expend the greatest part of the applied force upon the craft and the least upon the fluid. It is the screw which will create as little movement as possible in the fluid in which it operates.

In 1879 Mr. *Quinby* patented a device consisting of two sets of screw-like sails, one set to raise the machine and the other to propel it. The drawing shows a light framework with two screws, each with two blades of fabric, one set on a vertical mast, and the other upon an inclined mast. The screws were to be driven through rope gearing by some source of power.

In the same year Mr. *Greenough* also patented an apparatus, which should better, perhaps, be noticed under the head of aeroplanes, but which differed from this type by having lifting screws imbedded in the surface of the aeroplane, in order to obtain a lifting action upon first getting under way, after which, by sailing at an angle, both sustaining and propelling effect could be obtained from the screws, with, however, the possible addition of a vertical screw to give increased forward motion. This inventor is understood to have tried some preliminary experiments of details, and as a result thereof to be awaiting the development of a light motor before undertaking to realize his conception upon a navigable scale.

In 1885 Mr. *Foster* patented an air ship consisting of two screws, four-bladed, side by side, on separate vertical shafts, which latter can be thrown at an angle by reason of a flexible portion connecting with the main driving shaft, so that the thrust may both lift and propel the apparatus. The main shaft was to be driven by the feet of an operator sitting below and half way between the two screws. These screws are apparently some 8 ft. in diameter, and the man power relied upon is evidently inadequate, so that it is quite safe to say that if the apparatus was ever tried it did not succeed in rising.

(TO BE CONTINUED.)

THE INTERIOR LINE ALONG THE ATLANTIC COAST.

THE following statement, compiled by Mr. John C. Trautwine, Jr., from the notes of Captain S. C. McCorkle, for the *Proceedings* of the Engineers' Club of Philadelphia, shows how far the way for the interior or land-locked line from New York to Florida is already prepared.

Briefly outlined, the route from New York City to Charleston would pass through Raritan Bay and up the Raritan River to New Brunswick, N. J.; through the Delaware & Raritan Canal to Bordentown, N. J.; down the Delaware River to Delaware City; through the Delaware & Chesapeake Canal to Chesapeake Bay; down this bay to Norfolk, Va.; from Portsmouth (opposite Norfolk) up Southern River and through the Albemarle & Chesapeake Canal, North Landing River, Currituck Sound, a short canal and the North River, into Albemarle & Pamlico Sounds; and thence through Core Sound to Beaufort and Moorhead City, N. C.; thence by sheltered inlets, on which some work would be required, to Cape Fear River, N. C.; and from this point, by a series of streams and bays and sheltered inlets, aided by canals, existing and contemplated, to Charleston, S. C.

From New York to Beaufort and Moorhead City, N. C., the route is already open to vessels drawing 7 ft., except that some little dredging would be required at Piney Point, in Core Sound, between Pamlico Sound and Beaufort.

The "Bight" inside Cape Lookout shoal, near Beaufort, is said, by Captain D. A. French, of the Lighthouse tender *Laurel*, to be "a splendid harbor with any wind wind in 18 ft. of water."

From Moorhead City to near Bogue Inlet, 25 miles, the least depth shown on the charts is 2.5 ft., but there are much greater intervening depths. From Bogue Inlet to New River Inlet, 15 miles, there are channels through sea marsh, but their depth has not yet been ascertained. From New River Inlet through Old Topsail Inlet to the western end of Myrtle Sound, 50 miles, the route passes through a series of bays and sounds, giving a nearly continuous water passage; but only a few soundings have here been made.

From Myrtle Bay a canal about 2.5 miles long would have to be cut through low ground to the channel of the Cape Fear River.

The total distance from Moorhead City to the Cape Fear by this route would be about 92.5 miles. Being all inside, it would avoid the shifting sand-bars of the North Carolina coast, and the dangerous navigation around Cape Lookout and Cape Fear; and judging from the success of the Albemarle & Chesapeake Canal, there is every reason to believe that it would remain in permanent and active operation.

From the Cape Fear River at Southport (formerly Smithville), N. C., to Charleston, S. C., there is an outside route of about 125 miles, with 14 ft. mean low water over the bar at the port at each end. This was formerly the mail route; and the steamers, although very frail and of small power, were very successful.

The inside route, about 140 miles long, between the same two points, would pass up Elizabeth River to Hickory Point, whence a canal two miles long would have to be cut

through swampy land to water communication with Lockwood's Folly, Shallotte Inlet and Little River Inlet. Between Little River Inlet and Morrill's Inlet, a distance of 30 miles, is a low, flat, swampy district, which would have to be specially surveyed, and probably some canaling would be required.

From Morrill's Inlet to Georgetown, S. C., there is water communication. Between Georgetown and Cape Romain River two short canals may be necessary, one of which (the U. S. canal) has been partially, if not fully, constructed.

From Cape Romain River to Long Island, *via* Bull's Bay and following the creeks, there is water all the way, but some straightening and dredging will doubtless be required. From Long Island to Charleston there is water communication, but the depth is not known.

There always has been an inland passage between Charleston and Fernandina. Before the building of the Savannah & Charleston Railroad, the mail and passengers bound south were always carried by boat from Charleston to Savannah; and the steamboats, after touching at Savannah, proceeded to Fernandina, etc.

Captain McCorkle holds that the advantages of inland navigation along our whole Atlantic and Gulf coast are of the first importance; and the object of this paper is to bring the matter before the public in a substantial shape. Both the Government and syndicates undertake large surveys that do not promise a tithe of the advantages that would accrue to a large number of the people of these United States from this great water connection.

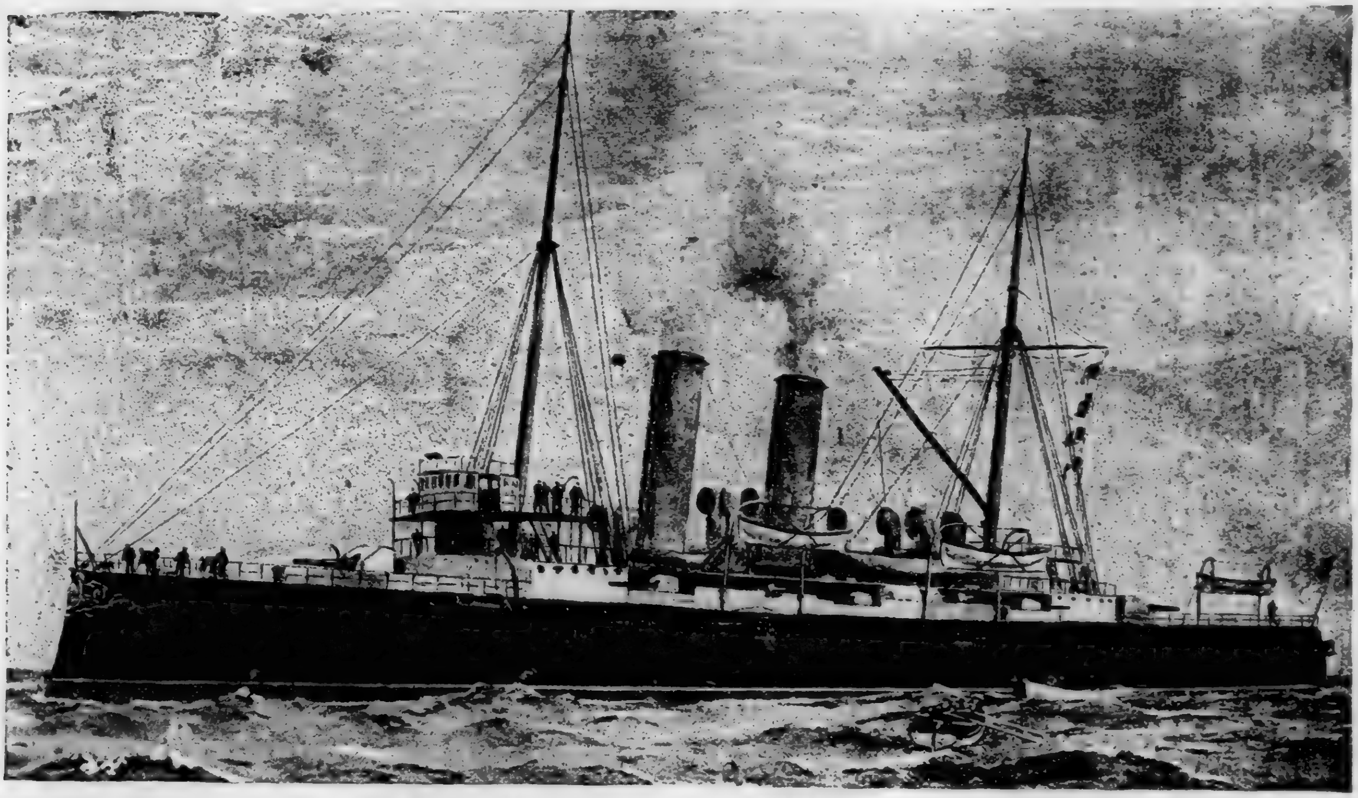
THE ENGLISH FAST CRUISER "EDGAR."

THE engraving given herewith shows the *Edgar*, one of the latest type of first-class fast cruisers built for the English Navy. The ship was built at Devonport, and the engines have been built by the Fairfield Ship-building & Engineering Company, of Glasgow, and have just received their trials.

The *Edgar* is an unarmored cruiser, and her general dimensions are: Length, 360 ft.; beam, 60 ft.; mean draft, 23 ft. 9 in.; displacement, 7,350 tons. She is of steel, with a double bottom, and has a protective deck extending the entire length, and varying from 2 in. to 5 in. in thickness. The engines and boilers are further protected by the arrangement of the coal bunkers. Outside of this there is no armor except that on the conning-tower and the gun shields.

The armament consists of two 9.2-in. 22-ton guns, placed on the upper deck, on center-pivot mounts, one forward and one aft; ten 6-in. rapid-fire guns, on center-pivot mounts, six on the upper deck and four in casements on the main deck. All these guns are protected by shields of 6-in. compound armor plates. The secondary battery includes twelve 6-pdr. and four 3-pdr. rapid-fire guns and seven fire-barrel Nordenfelt guns. There are also four torpedo-tubes, two opening above and two below the water-line.

The ship has a full equipment of electric lights, including search-lights. She is provided with artificial ventilation, water condensers and all the usual appliances.



THE FIRST-CLASS CRUISER "EDGAR," BRITISH NAVY.

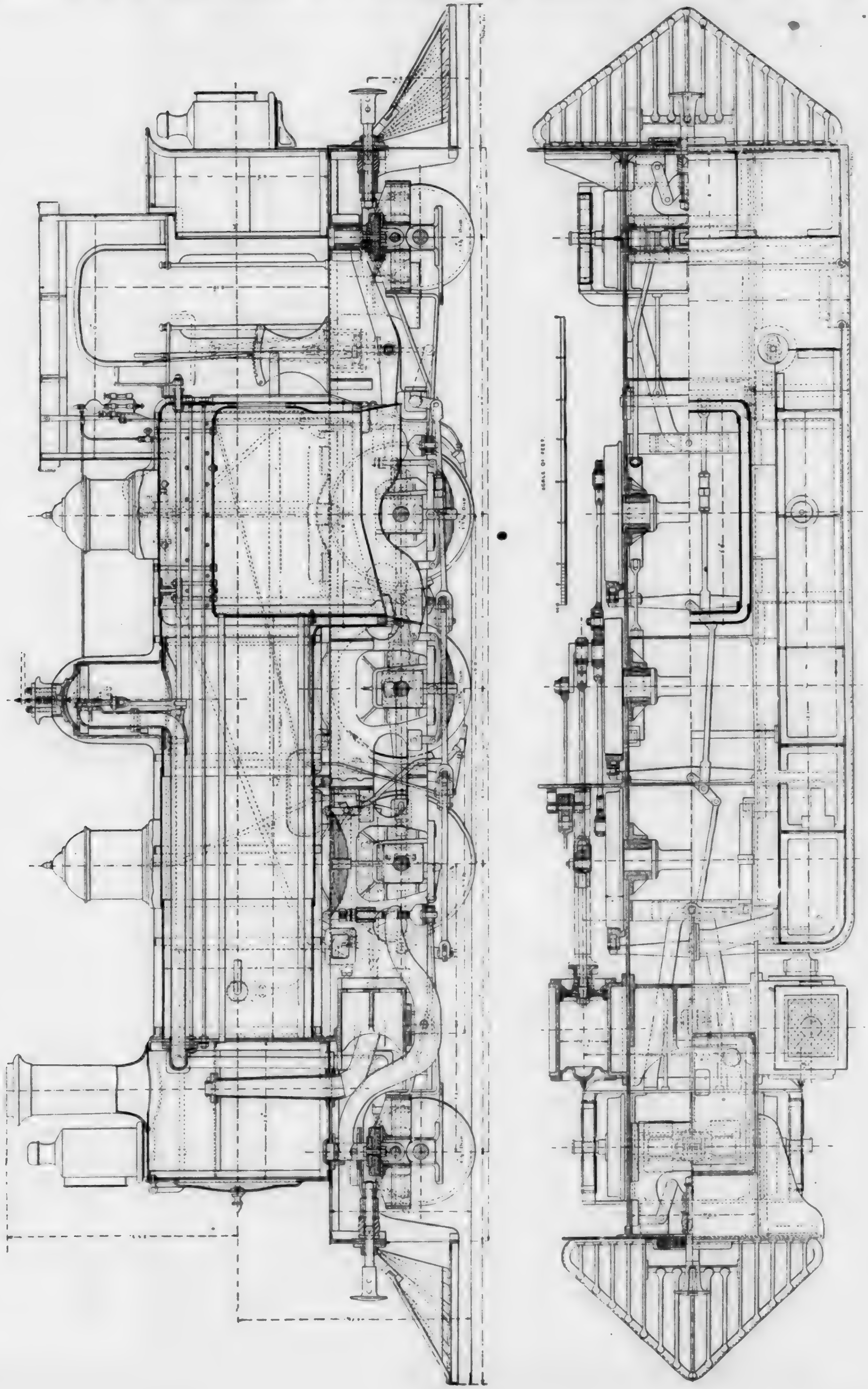
There are two screws, each driven by a vertical triple-expansion engine, with cylinders 40 in., 59 in. and 88 in. in diameter and 51 in. stroke. The condensers are of brass, and are placed alongside of the engines. There are circulating, bilge and feed pumps driven by separate engines. There are also small engines for starting and reversing the main engines.

Steam is supplied by four double-ended boilers 16 ft. in diameter and 18 ft. long, each with eight corrugated furnaces 3 ft. 9 in. in diameter, and one single-ended boiler 12 ft. 11 in. in diameter and 9 ft. 3 in. long, having three furnaces. The total grate area is 868 sq. ft., and the heating surface 25,411 sq. ft.; the ratio of grate area to heating surface is 1 : 29.26. The working pressure is 155 lbs.

The coal capacity is 850 tons on normal displacement, which gives the ship a cruising range of about 3,000 knots at full speed and of 10,000 knots at a 10-knot speed.

On the trial trips the engines of the *Edgar* developed 10,178 H.P. with natural draft. With forced draft, on a four hours' trial, they averaged 13,101 H.P., and gave the ship an average speed of 20.97 knots an hour. The boilers gave much more satisfactory results than in some other ships lately tried, showing no signs of weakness under forced draft. The artificial draft is on the closed stokehold system.

The cruisers of which the *Edgar* is a type are lighter vessels than the *New York* of our own Navy, having no armor belt. They might rather be classed with the fast cruiser No. 12, having nearly the same displacement,



TANK LOCOMOTIVE FOR NEW ZEALAND GOVERNMENT RAILROADS.

although they are 50 ft. shorter. The *Edgar*, moreover, has only two screws, and about two-thirds the engine power of No. 12. The *Edgar's* armament is also somewhat heavier in caliber, as the 9.2 in. guns are heavier than any No. 12 will carry. The two ships will have about the same cruising range, but No. 12 is expected to be the faster boat.

The *Edgar* has two masts, with fore-and-aft rig; there are no fighting tops. She is a very handsome vessel in appearance, the lines being fine, while the ship is free from the various erections on the upper deck with which some of the French cruisers are disfigured.

ROLLING STOCK FOR NEW ZEALAND RAILROADS.

In the accompanying illustrations, for which we are indebted to *Industries*, figs. 1 and 2 show the type of locomotive designed by Mr. J. P. Maxwell for the New Zealand Government Railroads. A perspective view of the engine was given in the February number of the JOURNAL, page 82; and some account of the railroads themselves was also given in the March number, page 113. The roads are of 3 ft. 6 in. gauge.

The engine, which was built at the shops at Christchurch, New Zealand, under charge of Locomotive Superintendent T. F. Rotherham, is intended to work a light traffic at moderate speeds over heavy grades. It has six driving wheels, a two-wheeled truck forward and another at the rear end, and is arranged to run in either direction without turning. Water is carried in two side tanks, and coal in a box on the foot plate.

The boiler is of Lowmoor iron plates $\frac{7}{16}$ in. thick, the barrel being 42 in. in diameter. The fire-box is of the Belpaire type, and the inside fire-box is of copper. The working pressure is 160 lbs.

The driving wheels are $39\frac{3}{4}$ in. in diameter, and are spaced 4 ft. 3 in. apart, the total fixed wheel-base being 8 ft. 6 in. The distance from center of forward drivers to forward truck is 7 ft.; from rear drivers to rear truck, 6 ft. 9 in., making the total wheel-base 22 ft. 3 in. The trucks are of the swing-bolster type, with $28\frac{1}{2}$-in. wheels and outside bearings. The springs of the forward drivers and the front truck are equalized, as are those of the four rear drivers and the rear truck.

The cylinders are 14 in. in diameter and 20 in. stroke; they are placed outside, with the steam-chests on top. The valve-gear is outside, and is of the Walschaert type. Balanced valves are used.

The frames are of steel $\frac{7}{8}$ in. thick, 3 ft. $0\frac{1}{4}$ in. apart, and the bogie frames are of the ordinary bar type. All the wheels, with the exception of the drivers, which are flangeless, are fitted with a water service, which is in constant use, and has given excellent results. Two pairs of wheels are fitted with Gresham & Craven's sanding apparatus. Care has been taken to reduce as far as possible the time and labor which constant attention to lubrication necessitates, and where possible all working parts are supplied from oil reservoirs, so situated that the syphons can easily be drawn when lubrication is not required, while the cylinders are fed from a sight-feed lubricator placed in the cab. Piston rods and valve spindles are provided with metallic packing. Two influx injectors are carried, one on each tank, the waste water being carried down to the ash-pan.

The ash-pan is fitted with perforated doors and dampers. The smoke-box requires no special mention, except that the chimney (which is in one piece), the smoke-box front, and door are of cast iron.

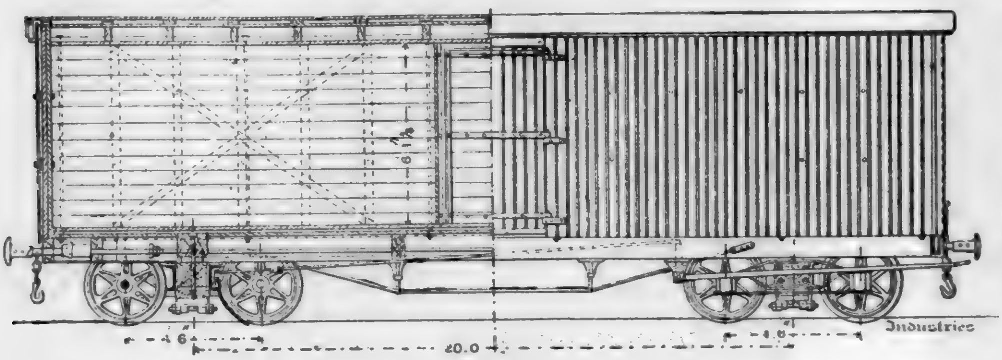


FIG. 3.

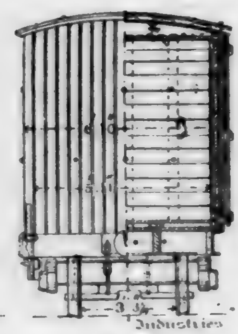


FIG. 4.

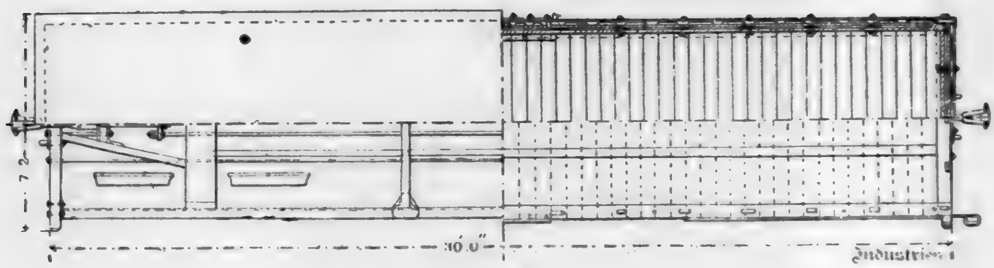


FIG. 5.

BOX CAR FOR NEW ZEALAND GOVERNMENT RAILROADS.

The brake gear on these engines is worthy of notice. It can be applied either by hand or steam, both acting on one and the same lever. A single adjusting nut only is required, and one great advantage in this gear lies in the fact that a new block may be placed on any one wheel without necessarily renewing the others, and without needing any adjustment.

This engine has been working for some time over grades as high as 160 ft. to the mile, and curves of 330 ft. radius, some of these being reverse curves, and the working load up this incline is 125 tons, exclusive of its own weight. The weight of this engine, with tanks and bunkers full and in complete working trim, is 36 tons, distributed as follows: $5\frac{1}{4}$ tons on each truck axle, leading and trailing, and $8\frac{1}{2}$ tons on each coupled axle.

The car, shown in figs. 3, 4 and 5, is an eight-wheel box car of the American pattern. It is of a class built especially to carry meat. It is 30 ft. long over all; 7 ft. 2 in. extreme width; 6 ft. 10 in. wide outside box, and 5 ft. 11 in. inside, the side sheathing being double. It is 6 ft. 1 in. high in the clear, inside. The trucks are 20 ft. between centers; each has four 26-in. wheels, the axles being spaced 4 ft. 6 in. apart.

The stock cars are of very similar construction, the only difference being that they have open siding and different doors. The sheep cars are provided with a second deck. Small four-wheel cars are chiefly used for ordinary freight.

LOCOMOTIVE RETURNS FOR THE MONTH OF DECEMBER, 1891.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Top. & Santa Fé	593	477	....	....	353,563	2,082,786	4,368	....	....	....	....	....	87.30	....	....	6.01	7.24	0.29	0.20	6.59	1.64	21.97	....	...	1.59
Canadian Pacific	577	....	479,7[illegible]7	1,050,8[illegible]5	290,965	1,821,557	3,157	....	....	....	....	...	72.10	....	....	3.45	13.00	0.42	....	5.44	1.21	23.52	....	2.04	3.56
Chic., Burlington & Quincy	....	479	....	....	....	1,844,115	3,850	5.01	17.69	....	....	....	90.78	....	....	7.78	6.46	0.22	0.38	6.96	...	21.80	....	...	1.41
Chic., Milwaukee & St. Paul	801	...	....	....	....	2,536,016	3,166	...	....	....	....	....	80.26	....	...	4.47	8.43	0.27	....	6 86	....	20.03	....	...	2.05
Chicago & Northwestern	846	....	661,517	1,449,401	662,406	2,773,324	3,278	....	....	....	....	....	87.83	....	....	3.37	8.60	0.38	...	6.27	0.82	19.44	...	....	1.94
Cleve., Cinn., Chic., & St. L.	....	444	413,951	664,316	358,461	1,436,728	3,236	4.40	21.30	73.70	118.13	64.80	92.[illegible]	16.75	5.54	2.84	5.97	0.19	1.76	6.56	0.22	17.54	....	....	1.28
Cumberland & Penn.	22	20	5,660	34,523	....	40,183	2,009	....	....	....	....	....	86.96	....	.	10.60	4.60	0.50	....	....	...	17.50	....	....	1.09
D., L. & W., M. & E. Div.	....	156	152,341	292,203	15,800	460,344	2,951	....	....	...	....	....	62.73	....	....	4.11	9.78	0.33	....	6.00	....	20.22	....	....	3.07
Hannibal & St. Joseph	42	42	49,309	92,586	27,212	169,107	4,026	4.76	15.17	....	....	....	85.77	17.72	6.54	2.60	5.76	0.14	0.27	6.11	...	14.88	.. .	....	1.48
Kan. City, F. S. & Mem.	145	....	102,614	236,901	127,688	467,203	3,222	...	....	. ..	...	....	64.66	... .	....	2.66	5.60	0.21	0.63	7.10	...	16.20	....	...	1.68
Kan. City, Mem. & Birm.	41	39	37,691	60,354	7,041	105,086	2,695	....	....	....	....	....	69.18	....	...	3.15	3.83	0.86	...	6.97	....	14.79	....	. ..	1.06
Kan. City, St. J. & C. B.	44	41	58,868	43,448	40,524	142,840	3,247	5.00	19.75	...	....	....	65.32	13.45	4.46	9.72	5.52	0.13	0.28	5.59	....	21.24	....	....	1.99
Lake Shore & Mich. South	560	....	425,953	917,063	589,093	1,932,109	3,450	....	....	....	...	....	69.20	....	....	2.78	5.51	0.16	....	7.10	0.18	15.73	....	....	1.58
Louisville & Nashville	...	350	428,679	818,568	371,135	1,638,382	3,601	5.17	15.37	64.48	106.53	49.37	83.53	12.56	6.94	4.33	6.79	0.26	1.43	6.14	0.60	19.55	3.28	1.56	1.82
Manhattan Elevated	..	272	784,465	....	65,325	849,970	3,124	....	....	.. .	....	....	44.24	....	....	2.10	8.80	0.30	....	8.60	....	19.80	....	....	3.96
Mexican Central*	146	119	....	....	....	397,223	3,332	...	....	...	....	....	68.40	....	....	5.00	17.55	0.45	0.19	5.87	0.95	30.01	....	....	5.60
Minn., St. P. & S. S. M.	....	....	69,183	164,851	19,080	253,114	....	3.95	15.22	....	....	....	76.62	....	....	4.11	13.15	0.23	....	6.10	....	23.59	....	2.12	3.26
Missouri Pacific	339	300	....	....	....	1,120,801	3,736	4.50	17.08	....	....	....	89.97	15.75	6.95	4.23	6.65	0.32	1.38	6.28	1.28	20.14	4.15	1.38	1.46
N. Y., Lake Erie & West.	...	617	450,052	1,119,823	325,447	1,895,322	3,072	4.60	21.10	89.90	131.10	66.10	....	19.60	6.[illegible]	4.81	7.62	0.40	2.70	7.17	1.06	23.76	....	1.75	1.38
N. Y., Pennsylvania & Ohio	....	261	149,929	477,078	140,020	767,027	2,939	5.00	17.40	78.90	115.10	70.40	....	15.90	6.60	4.16	6.53	0.32	3.00	6.74	1.03	21.78	....	1.85	1.30
N. Y., Ontario & Western.	113	101	....	....	....	271,269	2,686	....	... .	...	....	....	108.30	...	....	4.30	9.80	0.40	....	6.00	0.80	21.30	....	....	2.18
N. Y., Prov. & Boston	....	90	103,776	52,404	64,740	220,920	2,455	...	....	...	....	....	54.37	....	....	2.93	9.71	0.50	...	6.30	0.89	20.93	....	....	....
Old Colony	....	220	338,358	128,374	131,441	598,173	2,719	....	....	....	....	....	59.65	....	....	2.94	11.94	0.62	...	6.78	0.81	23.09	...	....	4.00
Philadelphia & Reading	....	....	451,282	804,953	550,761	1,806,996	....	....	....	....	....	....	87.33	....	...	3.99	4.73	0.30	....	5.77	0.38	15.17	....	....	......
South. Pacific, Pacific Sys.	....	700	....	....	....	1,670,778	2,387	....	....	...	....	...	61.69	....	....	5.04	19.22	0.25	1.91	7.31	1.81	35.54	....	....	5.83
Wabash	399	359	420,404	785,138	277,438	1,482,980	4,131	4.79	18.25	69.06	108.40	58.00	87.76	14.55	5.93	2.90	4.88	0.29	....	6 22	0.79	15.08	2.69	0.94	...
W.N. Y. & Penn., S. G. L.	....	123	90,588	168,442	71,000	330,050	2,684	....	....	...	....	....	77.52	...	....	2.62	3.88	0.32	. .	6.55	...	13.37	....	....	1.00
" " N. G. L.	....	6	8,119	4,330	2,310	14,758	2,460	...	....	...	....	....	47.51	...	....	3.48	2.38	0.27	....	6.16	....	12.29	....	....	1.00
Wisconsin Central	156	120	138,908	268,500	59,316	466,725	3,889	.. .	....	...	....	....	82.07	....	....	2.99	10.50	0.24	....	7.00	....	20.73	....	....	2.82
Year ending Dec. 31, 1891.																									
Atchison, Top. & Santa Fé	794	701	....	....	3,763,707	23,742,607	33,870	...	....	....	....	....	80.42	....	....	4.93	7.11	0.35	0.16	6.69	1.49	20.73	....	....	1.71
Canadian Pacific	....	577	5,696,371	9,972,669	3,071,439	19,840,479	33,762	....	....	...	....	....	63.94	....	....	3.92	11.49	0.41	...	5.31	1.26	22.39	....	2.01	3.56
Cumberland & Penn.	28	24	....	65,495	384,227	449,722	18,738	....	....	....	....	....	83.33	....	....	11.30	4.50	0.40	....	...	2.00	18.20	.. .	....	....
Kan. City, St. Jo. & C. B.	45	45	703,428	512,937	427,797	....	36,537	4.49	19.49	....	....	....	58.11	12.32	3.87	3.67	5.45	0.17	0.48	6.00	....	15.77	....	....	2.04
Missouri Pacific	....	300	....	....	....	12,490,140	41,634	5.20	12.24	....	....	....	80.39	14.23	6.39	4.56	6.01	0.36	1.34	6.34	1.27	19.88	4.06	1.44	1.45

* The Mexican Central Railway reports 16.8 units of work per $1 of expenses; 167.6 units of work per ton of coal; 11.9 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

THE UNITED STATES NAVY.

THE experiments on cellulose have been carried out at the Indian Head proving ground. They consisted in firing projectiles through boxes or tanks filled with cellulose and then submerging the tanks in water, the object being to test the extent to which this material will protect the sides of a vessel when pierced by shot. One of the cases was filled with the material in the ordinary way; in the other the cellulose was packed in small water-proof bags. The results have not yet been reported.

THE new cruiser *Raleigh* was to be launched at the Norfolk Navy Yard March 31. The *Raleigh* is an unarmored steel twin-screw cruiser, 300 ft. long, 42 ft. wide, 18 ft. mean draft and 3,083 tons displacement. The other cruiser of this class, the *Cincinnati*, is under construction at the New York Navy Yard.

IT is not probable that many new ships will be authorized by Congress this year. The Senate Naval Committee has reported in favor of building two new battle ships, two coast defense vessels, five light draft gunboats and light torpedo-boats; but the House Committee's bill as prepared only authorizes one new ship, an armored cruiser of the same type as the *New York*. The result may be a compromise, but it does not seem likely that much addition will be made to the House plan.

THE E. W. Bliss Company in Brooklyn, N. Y., which is making the auto-mobile torpedoes ordered by the Navy Department, will begin the delivery during the present month, and it is stated that there will be no delay after that in completing the contract.

GENERAL BERDAN has submitted to the House Committee on Naval Affairs plans for a vessel 260 ft. in length, 40 ft. beam, and about 2,400 tons displacement, to be armed with an enormous submarine gun carried in the bow below the water-line. His vessel is, in effect, a gigantic torpedo-boat, and his object is to destroy a ship by running his vessel as close to it as possible and firing under water. The plan is not altogether a new one. The proposed ship bears some resemblance to the Ericsson submarine boat, and General Berdan himself has been trying to draw attention to it for a number of years past.

VENTILATING THE BALTIMORE TUNNELS.

THE Pennsylvania Railroad Company, at the suggestion of Mr. George C. Wilkins, General Agent, has decided to establish a system of tunnel ventilation in connection with the tunnels of the Company in Baltimore. Mr. William H. Brown, Chief Engineer of the Pennsylvania Railroad system, has made an examination of the difficulties to be overcome, and plans have been prepared for the necessary appliances. It is proposed to erect a ventilating stack and fan midway over each of the long sections of the Baltimore & Potomac and the Union Railroad tunnels. The fans will be operated by electricity from a central power-house, located near the North Avenue end of the Bolton Yard. This power-house will be 40 × 60 ft. in area. It will be a neat brick structure, with one end of timber covered with corrugated sheet iron, so that this end can be removed and the building enlarged if necessary. The plant will include an engine, four boilers, a generator and the necessary electrical apparatus. The currents for the operation of the fans will be conducted by wires, which can be run through the tunnel or above ground to the ventilating shafts. From this central power-house it is also intended to light the tunnels by electricity.

The ventilation will be accomplished by building a slanting subway 8 ft. wide by 16 ft. high from the side of the tunnel, near its top, to the foot of the ventilating stack, which, on account of the heavy foundation necessary, will be located at the side of the tunnel. At the foot of the stack a huge fan fashioned like the blades of a steamboat propeller will be revolved on a vertical shaft, creating a strong draft toward the top of the stack. The vacuum created at the middle of the tunnel will cause the smoke and gas to be drawn from the ends of the tunnel to its middle, and out of the top of the stack. The stacks are to be 100 ft. high and 18 ft. square. They will be ornamented with panelings of brick, and with belt courses of terra cotta and covered with a top coping of light-blue stone. Adjoining each stack a small ornamental brick house will be erected for the storage of oil and materials used in operating the system.

Owing to the smoke and gas being thrown off at such a great height, and also by reason of the fan being practically noiseless, through the use of electricity, the disagreeable features are reduced to a minimum, so that the persons living near the stacks will be subject to very little annoyance. By this system it is said the tunnel will be cleared of smoke and gas in less than two minutes after the passage of a train, so that when another train enters the tunnel will be clear. The car windows will not have to be closed as at present, and the feeling of suffocation now experienced in passing through the tunnel will be obviated.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

BY JAMES K. GEDDES, C.E.

A LARGE percentage of the railroad mileage of this country is now standard gauge, and much of the remaining mileage will before long be changed to the standard.

In many foreign countries, however, especially in Mexico and in the Central and South American States, the gauges of the railroads are far from uniform, with but little apparent inclination to better the state of affairs as the many new lines are projected and built.

Thus, in Chili the following are the railroad gauges, with mileage, as given in Poor's Manual for 1890—viz.:

Gauge	2 ft. 6 in.	miles operated	273
"	3 ft. $3\frac{3}{8}$ in.	" "	56
"	3 ft. 6 in.	" "	185
"	4 ft. 2 in.	" "	98
"	4 ft. $8\frac{1}{2}$ in.	" "	390
"	5 ft. 6 in.	" "	747
"	not given	" "	474

Some of the other South American States have nearly or quite as great a diversity.

In 1885, of the railroads of the world, 74 per cent. of the mileage was of 4 ft. $8\frac{1}{2}$ in. gauge, and 26 per cent. of other gauges.

Even in this country there are many mountain and local lines that will not warrant a change of gauge till there is a radical change in the volume of traffic.

These lines for the most part (as to mileage) of 3 ft. or of meter gauge commonly have at least one terminus at some point reached by the standard gauge, and the transfer of freight and passengers from the one to the other is commonly a matter of much expense and annoyance. More particularly is this the case where the narrow-gauge line forms a branch of some standard-gauge line.

To facilitate such a transfer of business, it is now common to lay a third rail on the tracks in terminal yards, so that narrow and standard-gauge rolling stock can be used in such yards in common.

To lay such a third rail necessitates the putting in of *three-rail turnouts;* such turnouts are expensive, both in the cost of the frogs and other switch fixtures, as well as in the labor required in putting them in. Creditable practice requires that at least two of the frogs in a complete three-rail turnout should be curved to suit the respective alignments of the main track and the turnout. Every change in the radius of the turnout curve or in the alignment of the main track of course necessitates the use of a different set of frogs. Likewise a different set must be used when the turnout is to the right or to the left, or when the switch is a trailing or a facing switch, even though the respective alignments remain the same.

Thus a turnout from a tangent to the right requires a different set of frogs from a like turnout to the left; and a facing switch from a tangent requires a different set from that of a

trailing switch, though the frog numbers may be the same; in a way analogous to the manner in which a glove for the right hand is different from one for the left hand.

While the problems connected with three-rail turnouts are quite simple, and readily calculated by the use of plane trigonometry, they are commonly confusing from the large number of cases that present themselves.

It is the purpose in this paper to discuss the manner of the ready solution of such problems as are likely to be presented to the engineer. To this end formulas for such cases are deduced, and, to further simplify the matter, numerous numerical examples are given. From the formulas and numerical examples thus given, it is believed that the engineer may, without difficulty, find just what he may want, and readily apply the proper formulas to any particular case.

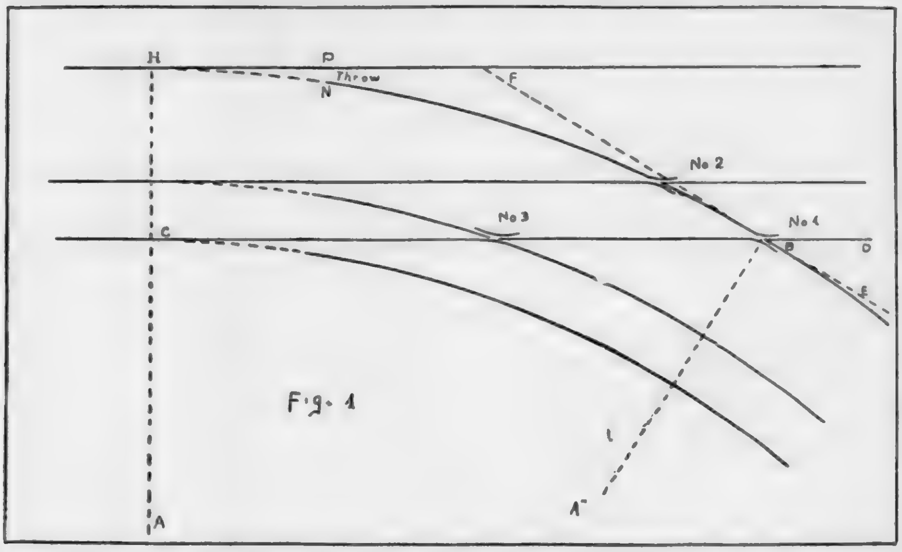


Fig. 1

It may be noted that while the formulas are primarily prepared for the solution of three-rail turnouts, many of them are equally applicable to all the cases that are likely to occur for ordinary turnouts, not only from tangents but from curves as well.

In the following discussion the turnout curve will be regarded as a circular curve, that representing the outer rail $H B$, fig. 1, being tangent to the line $F H$ and $F B$, these tangents being of equal length where H represents the heel of the switch and B the point of the frog.

This method of regarding the turnouts will be found to agree as closely with actual practice as other methods in vogue, and, besides, has the merit of simplicity.

In this connection, it may be remarked, that for ordinary turnouts, Parsons, in his "Turnouts," regards the turnout curve as circular.

In the case of three-rail turnouts, we commonly have the gauges, the alignment of the main track and that of the turnout given to find the length of the throw rail, the frog angle and the length of the chord, or the arc from the heel of the switch to the point of frog; or we have the alignment of the main track, one of the frog angles and the gauges, to find the length of the throw rails, the radius of the turnout, the remaining frog angles and the length of chord or arc from the heel of the switch to the point of the frog.

TURNOUTS FROM A TANGENT.

We will first consider turnouts from a tangent.

Length of Throw Rails.—To find the length of throw rails, it is only necessary to determine the length of the chord $H N$, fig. 1, having given the throw $P N$ and the radius of the turnout curve.

Letting D equal the chord deflection, or twice the throw, C, the length of chord required, and R, the radius, Henck (Prob. 18) shows that $d = \frac{c^2}{R}$, whence we have:

$$c = \sqrt{R d}. \qquad (1)$$

Example:

Let the throw be 5 in. and the radius 762.75. Required the chord length of the throw rail.

Twice the throw = 10 in. = 0.833 ft.	$\bar{1}.9206450$
$R = 762.75$	2.8823822
Extracting sq. root	2)2.8030272
$C = 25$ ft. $2\frac{1}{2}$ in. $= 25.206$	1.4015136

In common practice there may be eight cases of turnouts from a tangent, as follows:

1. Turnout to the right, with third rail on the right of center, facing switch A, fig. 2.
2. Turnout to the left, with third rail on the right of center, facing switch B, fig. 2.
3. Turnout to the right, with third rail on the right of center, trailing switch C, fig. 2.
4. Turnout to the left, with third rail on the right of center, trailing switch D, fig. 2.
5. Turnout to the left, with third rail on the left of center, facing switch E, fig. 3.
6. Turnout to the right, with third rail on the left of center, facing switch F, fig. 3.
7. Turnout to the left, with third rail on the left of center, trailing switch G, fig. 3.
8. Turnout to the right, with third rail on the left of center, trailing switch H, fig. 3.

These eight cases are reduced to four, for it may be readily shown that the switch A, fig. 2, is identical with that at H, fig. 3; that the switch at B, fig. 2, is identical with that at G, fig. 3; that the switch at C, fig. 2, is identical with that at F, fig. 3, and that the switch at D, fig. 2, is identical with that at E, fig. 3. We will therefore consider the first four cases only.

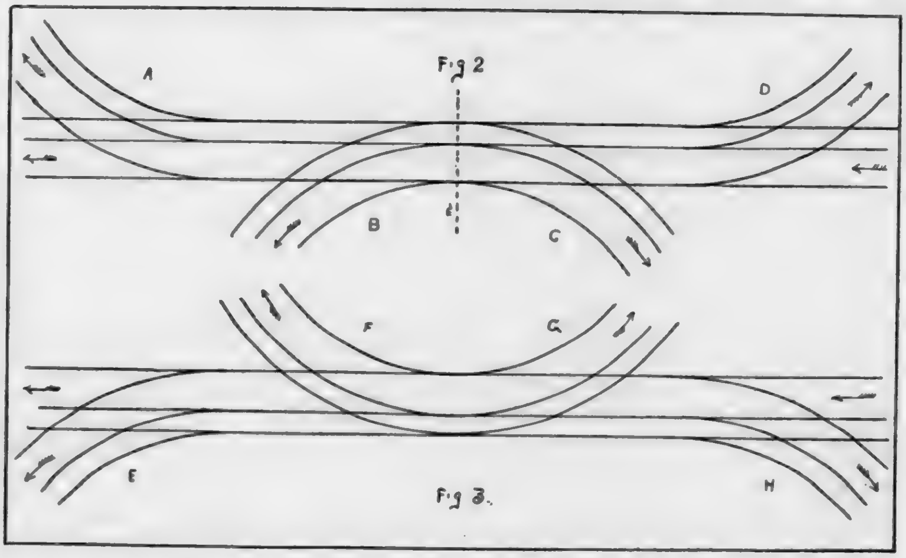


Fig 2

Fig 3.

In this connection it may be remarked that there may be cases in which the third rail may be placed in the center of the track—a condition not likely to occur in practice; and these will not be considered further than to say that they may be disposed of in a manner analogous to that employed in the other cases.

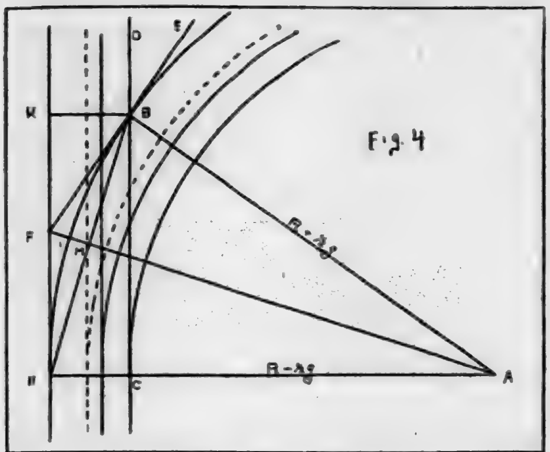
CASE I.

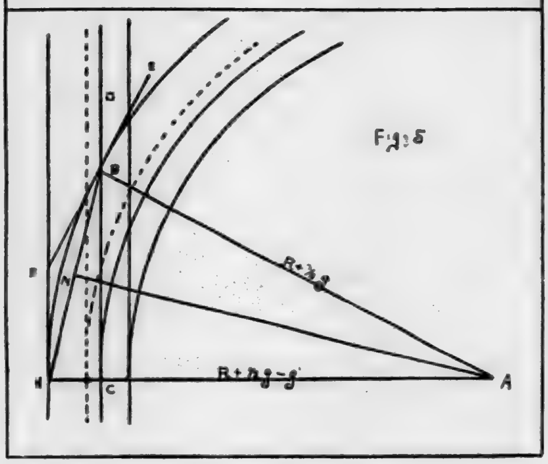
We will now consider Case I.

First let it be required to find the frog angle $D B E$, fig.

4, of the first frog, given the radius R, the standard gauge g and the narrow gauge g'.

The frog angle $D\,B\,E$ is equal to the central angle





$B\,A\,C$. For we have $D\,B\,E = F\,B\,C$, and since both are right angles, we have $F\,B\,A = B\,C\,A$. We find that

$$F\,B\,A = A\,B\,C + F\,B\,C$$
$$B\,C\,A = A\,B\,C + B\,A\,C$$

from which we have

$$B\,A\,C = F\,B\,C = D\,B\,E.$$

From a further inspection of fig. 4, it is evident that the distance $A\,H = A\,B$. From the center of the turnout curve to the outer rail of the turnout is equal to $R + \frac{1}{2}g$.

It is likewise evident that the distance $A\,C$ from the center of the turnout curve to the inner rail of the turnout is equal to $R - \frac{1}{2}g$.

Since $A\,C$ is perpendicular to $B\,C$, we have given the sides $A\,B = R + \frac{1}{2}g$ and $A\,C = R - \frac{1}{2}g$ of the right-angled triangle $A\,B\,C$ to find the angle $B\,A\,C$. By trigonometry we have

$$\text{Cos. } B\,A\,C = \frac{R - \frac{1}{2}g}{R + \frac{1}{2}g}. \qquad (2)$$

Example:

Given $R = 762.75$ and $g = 4$ ft. $- 8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\,B\,E = B\,A\,C$, fig. 4:

$R - \frac{1}{2}g = 760.396$ 2.8810398
$R + \frac{1}{2}g = 765.104$ 2.8837205

$B\,A\,C = 6°\ 21'\ 34''$ .... *cos.* 9.9973193

To find the frog angle of the second frog $D\,B\,E$, fig. 5.

It may be shown, in a like manner to that just shown, in the first section of Case I, that the frog angle $D\,B\,E$ is equal to the central angle $B\,A\,C$.

In this case $A\,B$ must be again equal to $R + \frac{1}{2}g$, but $A\,C$ is here equal to $R + \frac{1}{2}g - g'$.

Likewise we again have the sides of the right-angled triangle $A\,B = R + \frac{1}{2}g$ and $A\,C = R + \frac{1}{2}g - g'$ to find the angle $B\,A\,C$.

We now have

$$\text{Cos. } B\,A\,C = \frac{R + \frac{1}{2}g - g'}{R + \frac{1}{2}g}. \qquad (3)$$

Example:

As an example, let there be given $R = 762.75$, $g = 4$ ft. $- 8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft. to find the frog angle $D\,B\,E = B\,A\,C$, fig. 5.

$R + \frac{1}{2}g - g' = 762.104$ 2.8820143
$R + \frac{1}{2}g = 765.104$ 2.8837205

$B\,A\,C = 5°\ 4'\ 31''$ .... *cos.* 9.9982938

To find the frog angle of the third or double-pointed frog, fig. 6.

Again, we have the frog angle $D\,B\,E$ equal to the central angle $B\,A\,C$.

Here $A\,B$ is equal to $R + \frac{1}{2}g - g'$ and $A\,C = R - \frac{1}{2}g$.

Then in the right-angled triangle $A\,B\,C$ we have $A\,B = R + \frac{1}{2}g - g'$ and $A\,C = R - \frac{1}{2}g$, from which

$$\text{Cos. } B\,A\,C = \frac{R - \frac{1}{2}g}{R + \frac{1}{2}g - g'}. \qquad (4)$$

Example:

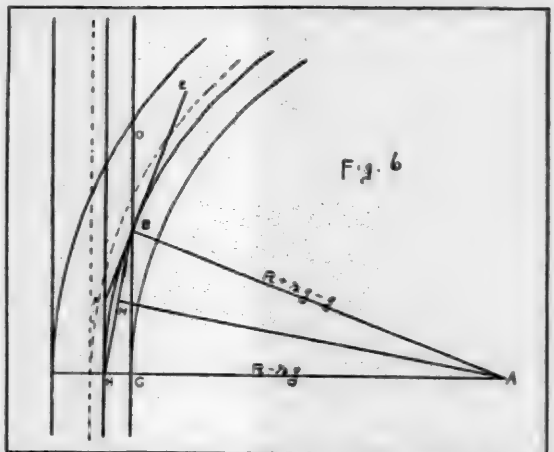
As in the last two examples given, let $R = 762.75$, $g = 4$ ft. $- 8\frac{1}{2}$ in. $= 4.708$, and $g' = 3$ ft. to find the frog angle $D\,B\,E = B\,A\,C$, fig. 6.

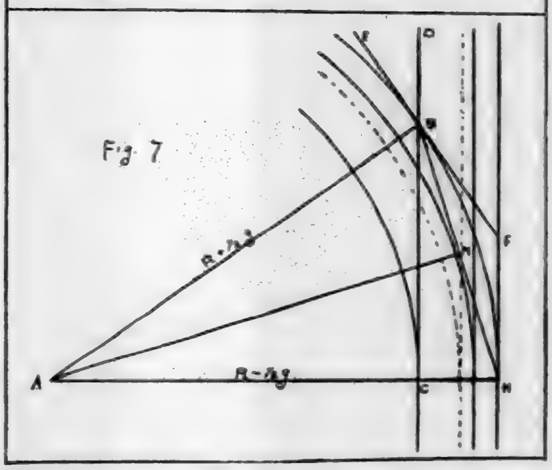
$R - \frac{1}{2}g = 760.396$ 2.8810398
$R + \frac{1}{2}g - g' = 762.104$ 2.8820143

$B\,A\,C = 3°\ 50'\ 13''$ .... *cos.* 9.9990255

To find the radius of the turnout curve:

When the conditions are that it is desired to find the





radius, the gauge and the frog angle being given, we may proceed as follows:

In fig. 4 let $D\,B\,E = K\,F\,B$ and $K\,B = g$. Then in the right-angled triangle $K\,F\,B$ the tangent

$$F\,B = \frac{g}{\text{sin. } K\,F\,B}. \qquad (5)$$

Now, in the right-angled triangle $A\,B\,F$ there are given the three angles and the side $F\,B$, from which

$$R + \tfrac{1}{2}g = F\,B \times \text{Cot. } B\,A\,F. \qquad (6)$$

Example :

Given the frog angle $= 6° \; 21' \; 34''$ and the gauge $= 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the radius $= R$, fig. 4.

$g = 4.708$ 0.6728365
$K\,F\,B = 6° \; 21' \; 34''$ .... *sin.* 9.0444045

$F\,B = 42.504$ 1.6284320

Thus, having found the tangent $F\,B$, we make use of equation 6.

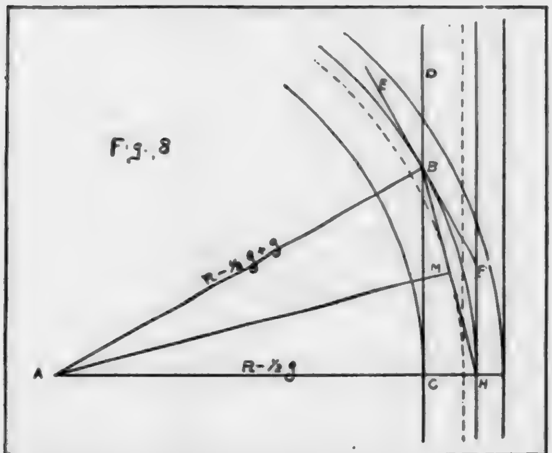
$F\,B = 42.504$ 1.6284320
Cot. $B\,A\,F = 3° \; 10' \; 47''$ 1.2552872

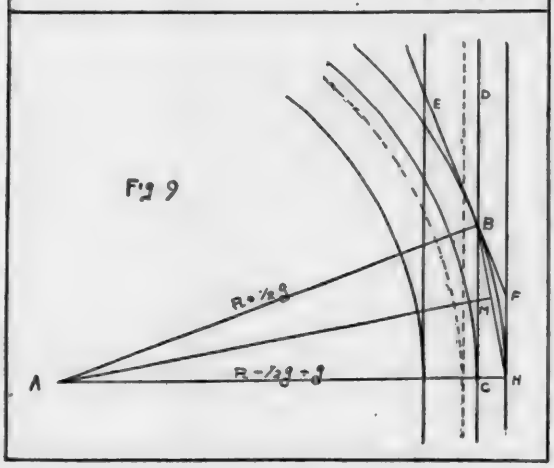
$R + \frac{1}{2}g = 765.102$ 2.8837192

Subtracting the $\frac{1}{2}g = 2.354$ from this result, we have as the radius 762.748.

To find the length of the chord $H\,B$, fig. 4, from heel of switch to point of frog :

In the triangle $A\,B\,M$ we have the angle $B\,A\,M = \frac{1}{2}$





$B\,A\,C$, since $A\,M$ bisects the chord $H\,B$. Then, since $A\,B = R + \frac{1}{2}g$, we have from trigonometry the $\frac{1}{2}$ chord

$$B\,M = R + \tfrac{1}{2}g \times Sin.\; B\,A\,M. \qquad (7)$$

Example :

Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and the angle $B\,A\,M = \frac{1}{2}\,B\,A\,C = 3° \; 10' \; 47''$, to find the chord $H\,B$, fig. 4 :

$R + \frac{1}{2}g = 765.104$ 2.8837205
$B\,A\,M = 3° \; 10' \; 47''$ .... *sin.* 8.7440436

$B\,M = 42.439$ 1.6277641

whence $H\,B = 84.88 = 84$ ft. $10\frac{1}{2}$ in.

In a similar manner the chord length may be found for any case.

To find the length of the arc from the heel of the switch to point of frog :

If it be desired to find the length of the arc measured along the outer rail of the turnout curve from the heel of the switch to point of frog, we may proceed as follows :

Represent the angle $B\,A\,C$, fig. 4, by a and the radius $A\,B$ by r.

Then the whole arc of the circle of which r is the radius is equal to $2\,r\,\pi$, and the part of the arc included by the angle a must be given by the equation

$$\text{Arc } B\,H = 2\,r\,\pi\,\frac{a}{360°}. \qquad (8)$$

Example : Let

$a = 6° \; 21' \; 35''$,
$r = 765.104$.

Then

$2\,r = 1530.208$ 3.1847505
$\pi = 3.1416$ 0.4971499
$6° \; 21' \; 35'' = 22895''$ 4.3597406
$360° = 1296000''$ ar. comp. 3.8873950

84.925 ft. $= 84$ ft. $11\frac{1}{8}$ in. 1.9290360

In a similar manner the length of an arc along the outer rail from the heel of the switch to the point of frog may be found for any other case.

CASE II.

We will now consider the second case, where the facing switch is to the left, with the third rail on the right.

To find the frog angle of the first frog $D\,B\,E$, fig. 7 :

As in Case I, we will first consider the determination of the frog angle $D\,B\,E = B\,A\,C$, fig. 7, of the first frog, given the radius $= R$ and the standard gauge $= g$.

In the right-angled triangle $B\,A\,C$, fig. 7, we have given the sides $A\,B = R + \frac{1}{2}g$ and $A\,C = R - \frac{1}{2}g$ to find the angle $B\,A\,C$. By trigonometry we have

$$Cos.\; B\,A\,C = \frac{R - \frac{1}{2}g}{R + \frac{1}{2}g}, \qquad (9).$$

which is identical with equation (2), where the turnout is to the right. The frog angle in both these cases is, therefore, the same, and if the turnout is made a tangent from B toward E, the frogs in either case will be the same. If, however, the turnout is continued through the frog, both should be curved to the radius of the turnout curve, one to the right, the other to the left.

To find the frog angle of the second frog $D\,B\,E$, fig. 8 :

For the second frog angle $D\,B\,E = B\,A\,C$, fig. 8, we have in the right-angled triangle $B\,A\,C$, $A\,B = R - \frac{1}{2}g + g'$ and $A\,C = R - \frac{1}{2}g$, and from trigonometry we have

$$Cos.\; B\,A\,C = \frac{R - \frac{1}{2}g}{R - \frac{1}{2}g + g'}. \qquad (10)$$

Example :

Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft. to find the frog angle $D\,B\,E = B\,A\,C$, fig. 8 :

$R - \frac{1}{2}g = 760.396$ 2.8810398
$R - \frac{1}{2}g + g' = 763.396$ 2.8827499

$B\,A\,C = 5° \; 4' \; 52''$ .... *cos.* 9.9982899

In this particular example, the difference between this frog angle and that of the turnout to the right is so small that it may be neglected in practice. However, while the frog angles are practically the same, the frogs are different, in that one must be curved to the right and one to the left, to the radius of the turnout curve.

To find the frog angle of the third or double-pointed frog, fig. 9 :

We here have in the right-angled triangle $B\,A\,C$, $A\,B = R + \frac{1}{2}g$ and $A\,C = R - \frac{1}{2}g + g'$, whence

$$Cos.\; B\,A\,C = \frac{R - \frac{1}{2}g + g'}{R + \frac{1}{2}g}. \qquad (11)$$

Example :

Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft., to find the frog angle $D\,B\,E = B\,A\,C$, fig. 9 :

$R - \frac{1}{2}g + g' = 763.396$ 2.8827499
$R + \frac{1}{2}g = 765.104$ 2.8837205

$B\,A\,C = 3° \; 49' \; 45''$ .... *cos.* 9.9990294

CASE III.

Let us now consider Case III., where the turnout is a trailing switch to the right *C*, fig. 2.

If the turnouts *B* and *C* of like radius have their "heel" in common, as *m n*, fig. 2, and the part of the figure to the right of *m n* be made to turn about the axis *m n* for 180°, the turnout *C* must correspond with that of *B*, and therefore the frog angles, chord length, length of lead, and length of throw rail for Case III are the same as for Case II. It must be observed, however, that the frogs are curved in opposite directions.

CASE IV.

In a similar manner it may be shown that the frog angles, chord length, length of lead and length of throw-rail of the trailing switch to the left, *D*, fig. 2, are the same as these for *A*, fig. 2; Case I, it being here observed also that the frogs are curved in opposite directions.

It will thus be seen that, having calculated the functions for the turnouts for any one of the particular cases discussed, the results, so far as required by practice, will answer for any of the other cases, care only being taken to have the frogs curved in the required direction. As before observed, the first frog need not be curved at all. The second and third should be properly curved in all cases. The second frog can only be curved in two ways for all the cases discussed, while the third or double-pointed frog may be curved in four different ways.

(TO BE CONTINUED.)

A FORTIFIED RAILROAD STATION.

(From *Indian Engineering*.)

In plan the station at Lahore is a parallelogram, the interior space between the two sides through which the line passes being entirely covered in with corrugated iron roofing resting on iron trusses arranged in two spans; the inner ends of these trusses rest on a central line of pointed arches on piers; the outer ends on the walls of the station premises in line with the platforms.

There are two platforms; that for the up train service is on the left (west) side, and the other for down traffic on the right (east) side.

In prolongation of these, and on the south down line end, outside the station, are the troop sidings with their necessary platforms.

Four sets of rails pass through the station—two on the up and two on the down-line side, so that through working can conveniently be maintained even when the regular trains are at rest within the station.

The entrances to the station premises (carriage porches and passages) are placed in or about the center of the two sides, and communication across line, with the two platforms, is by means of an overhead bridge opposite to—*i.e.*, in line with—these main entrances.

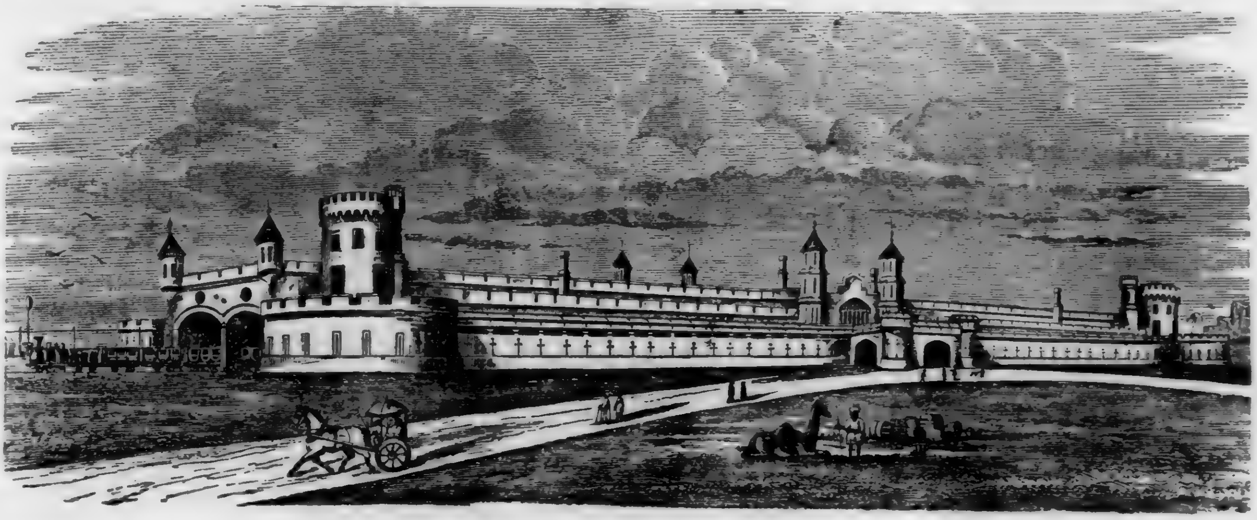
On the east (down line) platform are placed the Station Master's, booking, telegraph, and kindred offices; as also the refreshment rooms, waiting rooms, and other subsidiary accommodation for the convenience of passengers; while the greater portion of the accommodation on the west (up platform) side is appropriated to the use of the Manager's and Traffic Department offices.

Sheltered accommodation for third-class passengers is also provided within the premises, alongside the main entrances.

The illustration represents the exterior of the western face of the station (on which side is situated the civil station and City of Lahore) as also the train approaches from the north (or Peshawar) direction.

The building is of brickwork; that in the works added in recent years for the defense of the premises being of an exceptionally good quality. The style of building on the interior faces is similar to that in the other older stations on this (the Northwestern) line, such as Phillour, Umballa Cantonment, and the Shaharanpore station.

The defensive arrangements are clearly shown in the illustration. These consist of bastions at the angles with "keeps," or towers, above them; which command the several approaches and provide for a flanking defense of the curtains or outsides of the station, which also are loopholed for musketry fire over the surrounding neighborhood. This fire can be further strengthened from the several towers and turrets which overlook and command all surroundings in the immediate vicinity of the station.



FORTIFIED RAILROAD STATION AT LAHORE, INDIA.

These defensive arrangements appear to be all that is necessary to secure the station against an attack with small arms only or against a sudden rush, and further to provide for the refuge of the railroad staff and others in any time of danger.

There, however, appears to be no provision whatever for readily closing the end or train approaches; and in this respect the arrangements seem to be deficient, for in the absence of any kind of bullet-proof screens across these openings, those occupying the platforms would be exposed to considerable risks in any determined musketry attack directed against the north or south ends of the premises.

Of course the openings could, in case of emergency, be blocked up with impedimenta about the place; but at such a time rapid ingress and egress would become all the more important, and this would be seriously interfered with by resort to such a measure.

Falling shutters, or drawbridges, with proper counterweight arrangements would possibly be suitable for this purpose, and if these were provided and loopholed with the addition of a deep broad trench in front of these openings (which could be spanned by iron girders for train service), then the Lahore station would certainly be fairly well secured against any attack from without not supported by artillery.

Hodges' Steel Car.

THE accompanying illustrations show plans for the construction of a steel car prepared by Mr. H. C. Hodges, President of the Detroit Lubricator Company. In the drawings fig. 1 is an elevation of a car 70 ft. in length built to carry through freight; fig. 2 shows one end of a floor-frame, showing sills and the manner of connecting studding to the sills; fig. 2*a* shows a corner detail; fig. 3 shows a cross-tie and brace detail; fig. 4 shows in section the fastening of a stud to the side sill; fig. 5 shows a connecting fillet; fig. 6 shows in detail the fastening of the cross-tie to the middle sills; fig. 7 is a sectional elevation of a portion of a car, the figure representing two of the three trucks upon which the car rides; fig. 8 is a plan view showing at different parts of the figure the roof, the roof-frame, the floor-sills, and continuous draw-bar.

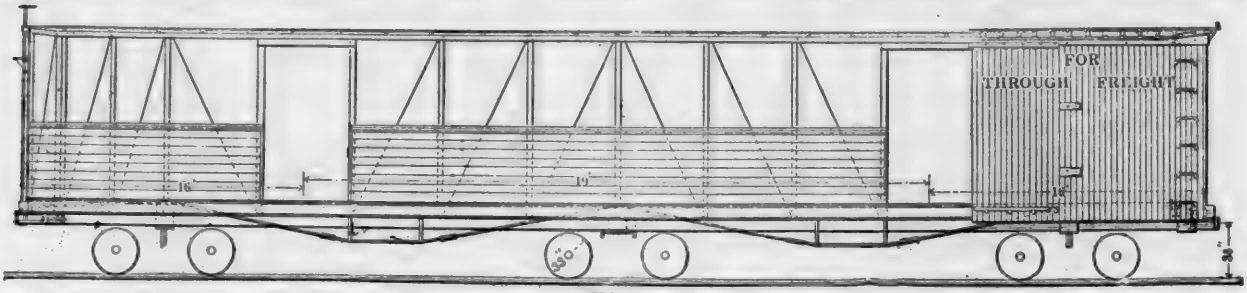


Fig. 1.

HODGES' STEEL FREIGHT CAR.

This method of car construction has for its object the construction of cars, both passenger and freight, of greater length, strength and carrying capacity than those now in use, without a corresponding increase in weight. This is accomplished by the use of a metal frame throughout, made up in the following manner: The side sills are formed by two steel channel-bars with their concave faces toward each other. The uprights are also channel steel, and are secured to the side sills by interposed cross-filling blocks (malleable iron), with the horizontal arm embedded within the channel of the side sill, and the vertical arm within the channel of the upright. It will be seen that when this joint has been completed, each part has a bearing against another part, and the bolts or rivets holding these parts together are relieved of all strain or shear. The center sills are compound channel or Z-bards, with crossed tie-plates placed between the flanges of the upper and lower members, also additional tie-plates extending above and below the central sills, and all secured to the side sills. The double central middle sills are rectangular in form, with middle flanges on either side, and are made continuous, extending from end to end, the lower halves passing under and beyond the end sills, thus forming a continuous draw-bar made integral with the car frame, and to which the draw-bars are attached. The end of the car is preferably made octagon or bay shape. The end sills are formed by uniting two channel or angle-plates with flanges overlapping in cross section, thus producing a double-webbed adjustable channel into which the ends of the longitudinal sills are placed and securely clamped. The corners of the car are formed by angle-plates overlapping, and secured to the side and end sills, and this also forms the corner upright, making a simple and strong combination at these points. By making the ends of the car octagon or bay shape, great additional strength is secured, with no perceptible loss in carrying capacity, and accidents incident to car coupling are practically avoided. The sides, ends, floor and lining are to be of wood. The roof is constructed of No. 22 corrugated steel plates of double thickness at each corrugation. The purlins are U shaped, and extend the entire length of the roof, with their concavities face to face with the roof channels, and are secured thereto by intermediate malleable iron filling blocks at each intersection.

There will be three trucks under this car, the frames made up wholly of steel shapes, the center truck being of the *equalizing type*, and provided with an *anti-friction parallel side motion* of simple design, and capable of adjusting itself to any curve in use on *trunk lines*. In cases where freight cars are of more than ordinary length, there may be two doors, located the same distance from the ends as on ordinary cars, thus giving every facility for loading and unloading that now exists with the common car. This plan is illustrated in fig. 1.

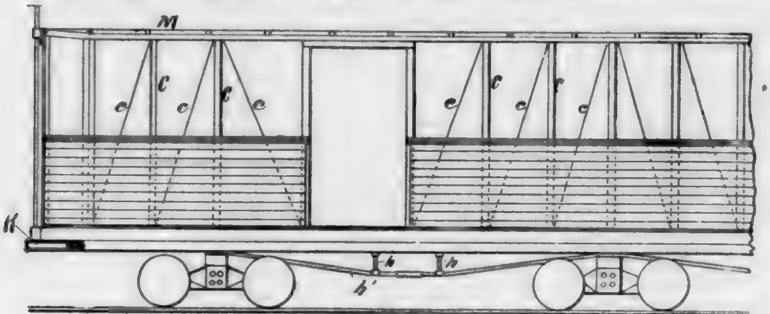


Fig 7

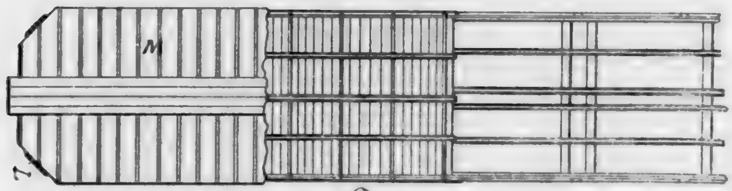
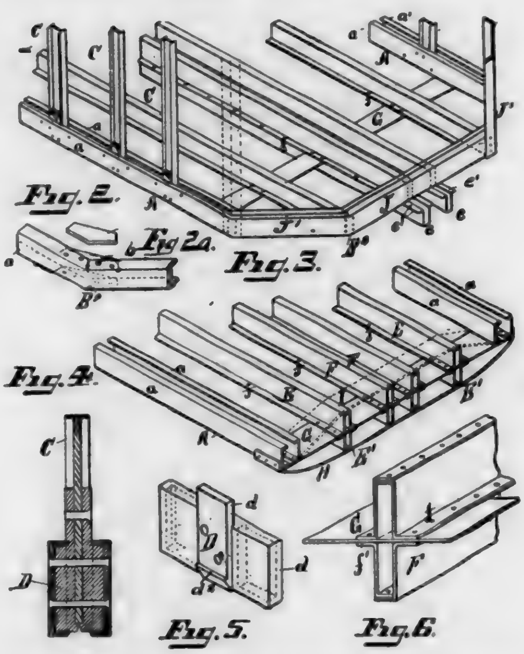


Fig 8.



Estimates relative to the cost of this construction show that it will but little exceed that of wooden cars per tonnage capacity. With slight modifications, the same methods can be applied in the construction of passenger cars, mail and express cars, and when so constructed, it is claimed that these cars will be practically invulnerable against fire and many other casualties, thereby saving loss of property and sacrifices of human lives incident to the present system of car construction, and these results can be obtained at a cost less than that of the cars actually in use.

The steel used in construction is of shapes easily rolled, and in fact commonly found on sale, so that few or no special shapes will be required in building it. While Mr. Hodges believes in the use of the long car for through business, his system of construction may be readily applied to cars of any size, while it makes the long car practicable by its additional strength.

Manufactures.

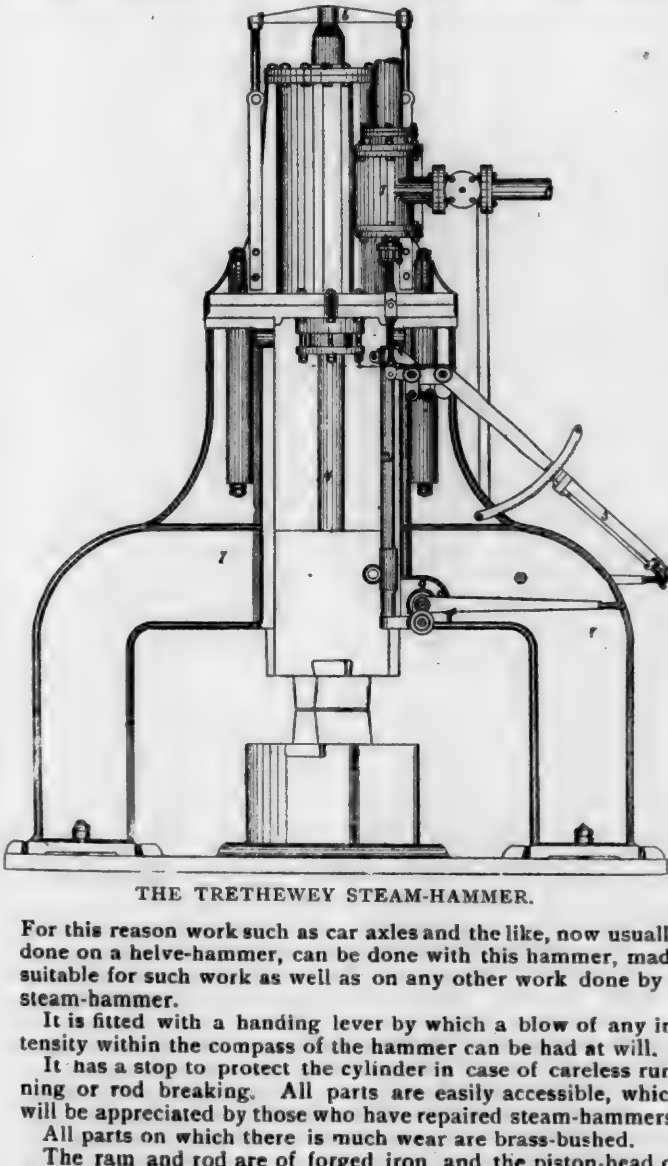
A New Steam-Hammer.

THE drawing herewith, from the *American Manufacturer*, shows a double-stand steam-hammer built by the Trethewey Manufacturing Company, of Pittsburgh.

This hammer, which is the result of much careful study, is fitted with the builders' patent balance and piston-valve, controlled by an adjustable slide-bar which is made movable to give greater or less travel to the valve as needed.

The advantages claimed for the adjustable slide-bar are:

1. The weight of the motion is carried on the stand.
2. The slide-bar can be adjusted to any angle desired.
3. By use of the slide-bar they are not dependent on the length of the ram to determine the length of the automatic stroke. The ram, therefore, can be made of any width desired.



THE TRETHEWEY STEAM-HAMMER.

For this reason work such as car axles and the like, now usually done on a helve-hammer, can be done with this hammer, made suitable for such work as well as on any other work done by a steam-hammer.

It is fitted with a handing lever by which a blow of any intensity within the compass of the hammer can be had at will.

It has a stop to protect the cylinder in case of careless running or rod breaking. All parts are easily accessible, which will be appreciated by those who have repaired steam-hammers.

All parts on which there is much wear are brass-bushed.

The ram and rod are of forged iron, and the piston-head of forged steel.

The stands are solid web, heavily flanged.

The different parts of the hammer designated by figures on the drawing are as follows: Piston-valve, 1; slide-bar, 2; ram, 3; rod, 4; handling-lever, 5; stop, 6; stands, 7.

These hammers are made in sizes from 150 lbs. upward.

General Notes.

THE Richmond Locomotive Works, Richmond, Va., are building 10 ten-wheel engines, with 19 × 24-in. cylinders, and 15 consolidation engines, with 20 × 24-in. cylinders, for the Chesapeake & Ohio Railroad.

THE contract for the new bridge over the Harlem River at Eighth Avenue, in New York City, has been let to the Passaic Rolling Mill Company, Paterson, N. J. The contract price for the bridge and approaches is $1,102,532. The plans for the structure were made by A. P. Boller.

THE Trethewey Manufacturing Company in Pittsburgh, Pa., has recently furnished the Republic Iron Company of that city with a 124 in. square shear, with engine attached. The tool weighs 35,000 lbs.

THE Jackson & Sharp Company in Wilmington, Del., has just completed an order for 25 passenger cars for the Lehigh Valley Railroad.

THE Burnham portable railroad drill was recently furnished to contractors who were building an electric railroad in Texas. One job to be done was drilling a ⅜-in. hole in each rail for the electric connection, the rails being scattered all along the line. Two men doing this work with the drill, at 2½ cents a hole, made $18 a week, which was certainly excellent work.

THE Congdon Brake Shoe Company is erecting an iron building 200 × 110 ft., which will contain a 12-ton open-hearth steel furnace and a 24-pot crucible steel furnace. It is expected that this plant will be in full operation by June next, making general steel castings and material for the Ross-Meehan brake shoes.

THE new iron steamship *Antinojenes Menendez* was launched from the Neafie & Levy yard in Philadelphia, February 27. This ship was built for Menendez & Company, of Havana, and will be used in the Cuban coasting trade. She has accommodations for 90 first-class passengers and a large cargo. Her dimensions are: Length, 238 ft.; beam, 35 ft.; depth of hold, 20 ft. 4 in.; draft, with 400 tons cargo, 9 ft. There are two compound, surface-condensing engines, with cylinders 20 in. and 40 in. in diameter and 28-in. stroke. The speed is about 13 knots an hour.

THE Pullman Car Works, Pullman, Ill., are building 85 passenger and 15 combination cars for the Philadelphia & Reading Railroad Company.

THE Lehigh Valley Car Works, at Stemton, Pa., are building 1,250 freight cars for the Central Railroad of New Jersey.

THE New York Central & Hudson River Railroad Company has let contracts for 1,000 coal cars to Murray, Dougall & Company, Milton, Pa.; 1,000 box cars to the Buffalo Car Company, Buffalo, N. Y.; and 1,000 box cars to the Peninsular Car Company, Detroit, Mich.

THE Lassig Bridge & Iron Works, of Chicago, Ill., are building two bridges for the Chicago, St. Paul, Minneapolis & Omaha Railroad. One is a bridge of two spans, each of 165 ft., over Black River at Black River Falls, and the other is an iron bridge 850 ft. long, in six spans, over the Chippewa River.

THE North Carolina Iron & Steel Company is building a new furnace at Greensboro, N. C. The stack is 70 ft. high and 14 ft. bosh, and will have a capacity of 33,000 tons a year. It will use local ores and Pocahontas coke.

THE Union Iron Works, San Francisco, Cal., have bought all the tools, machinery, patterns, etc., of the Pacific Iron Works. These will be used in extending the plant of the Union Works.

THE Egan Company, in Cincinnati, O., has made application for 20 000 sq. ft. of floor surface at the Columbian Exposition, and will show there over 40 different machines of its design and construction.

THE Detroit Dry Dock Company has contracted to build a new ferry-boat to run across the Straits of Mackinac, connecting the Duluth, South Shore & Atlantic Railroad with the Michigan Central and the Grand Rapids & Indiana railroads. The new steamer will be 300 ft. long over all, 52 ft. beam and 17 ft. draft. She will have a propeller at each end, the two screws being driven by separate compound engines. The new boat will be 70 ft. longer that the one now in use—the *St. Ignace*—but will be built in very much the same way, as that boat has had remarkable success in working through the ice, having made regular trips when she had to break through ice 3 ft. and over in thickness.

THE Buffalo Steam Forge Company has gone into the hands of a receiver. It is believed, however, that the difficulties can be adjusted and work resumed.

THE New England Engineering Company has been organized at Springfield, Mass., by William A. Harris and John Bartholomew. The new concern will contract for bridges, architectural iron work, elevators and castings of all descriptions.

THE Mexican International Steamship Company, recently organized in Philadelphia, has now completed its arrange-

ments, and will soon have a regular line in operation between Philadelphia and Mexican ports. Mr. Henry C. Ayer, of the firm of Pedrick & Ayer, is President of the Company.

THE St. Charles Car Company, St. Charles, Mo., is building 500 box cars for the Peavy Elevator Company; 200 coal cars for the Cairo Short Line, and 200 furniture cars for the Missouri Pacific. They have recently, in addition, closed contracts for 500 box and 200 flat cars for the Atchison, Topeka & Santa Fé, and for 1,000 box cars for the Missouri Pacific. The Passenger Department is now building 10 combination cars for the Lake Shore; 2 baggage cars for the Pittsburgh & Lake Erie; 3 passenger cars for the Wabash; 6 for the Des Moines & Northwestern, and 2 special circus cars for Ringland Brothers. Recent contracts, in addition to these, include 15 chair cars for the St. Louis & San Francisco Railroad and 5 baggage cars for the same road. The chair cars will have Scarritt chairs. Another contract is for 16 first-class cars for the Wabash. These cars will be 64 ft. long, will be provided with smoking-room and wash-rooms, and will be equipped with the Scarritt-Forney seat. They will be finished in mahogany and carried on 6-wheel trucks. Eight baggage cars for the same road will shortly be begun.

THE St. Charles Car Company has taken a contract to rebuild, repaint and put in first-class condition 75 narrow-gauge passenger cars for the Denver & Rio Grande; in order to do this work conveniently, a branch shop has been established at Denver, Col.

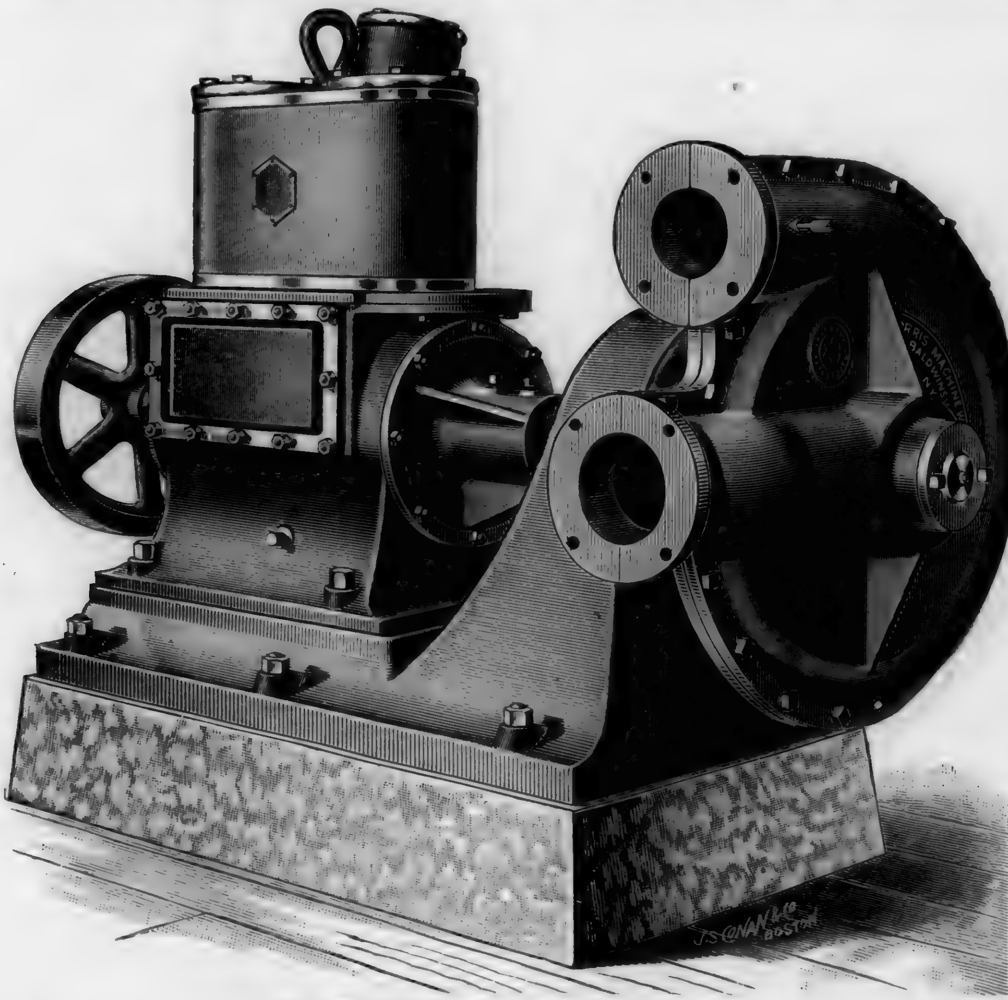
THE De La Vergne Refrigerating Machine Company has just completed one of the largest plants of this kind ever built for the Anheuser-Busch Brewing Company, in St. Louis, Mo. The capacity of this machine for refrigerating is equal to the work accomplished by the use of 500 tons of iron in 24 hours. The engine is a compound condensing engine of 600 H.P., having cylinders 32 and 64 in. in diameter and 48 in. stroke. The gas cylinders are double-acting, 24 in. in diameter and 48 in. stroke. The crank shaft is of iron 15½ in. in diameter and weighing 20,820 lbs. The machine occupies a floor space of 37 × 22 ft., and stands 28 ft. 6 in. high. Its total weight is about 175 tons. The steam engine is horizontal and the gas compressor is vertical. The two fly-wheels are 14 ft. 8 in. in diameter.

THE shops of E. P. Allis & Company, Milwaukee, Wis., are building a vertical, tandem, compound mine-pump engine for the Chaplin Mine, Iron Mountain, Mich. The cylinders measure respectively 50 in. and 100 in., with a stroke of 10 ft. The fly-wheel is 40 ft. in diameter and weighs 160 tons. The main shaft is 27 in. in diameter and the crank-pin 10 in. in diameter. The crank-shaft weighs nearly 8 tons. The beam is 32 ft. in length from center to center, and weighs 100 tons. The connecting-rod is 30 ft. in length from center to center, and 15 in. in diameter in the center. This engine is 54 ft. in height from bed plate, and is intended to work a line of 28 in. pumps against 1,500 ft. of head.

THE New York Central & Hudson River Company has decided to build extensive shops near Buffalo. They will be the largest and most important on the line, and will employ from 1,200 to 1,500 men when completed. A new town will be built up in connection with the shops, and will be named Depew. The company has bought 100 acres of land, and will begin work very soon.

THE Schenectady Locomotive Works have contracts for 100 locomotives for the New York Central.

A Combined Centrifugal Pump and Engine.



DIRECT-CONNECTED CENTRIFUGAL PUMP.

THE accompanying illustration shows a centrifugal pump driven directly by a high-speed engine. The advantages of a centrifugal pump for many purposes are well known, but in many cases they are partially neutralized where the pump is driven by a belt. In the arrangement shown the engine and pump are carried on the same bed-plate, making a very compact outfit, light for its capacity and taking up but little room.

The centrifugal pump can be used where water with solid matter in suspension has to be pumped, owing to its wide passages and the absence of valves. The arrangement shown has found favor in tanneries, where a composition pump is used to resist the ravages of the tan liquor; for circulating purposes on ship-board, and for circulating brine in freezing tanks of ice machinery; for raising sand and gravel from river beds, and conveying it ashore by means of a discharge pipe; for dredging and filling at one operation; for irrigation and drainage purposes, and for many other kinds of service. It has worked well both for small and large capacities.

The pump shown in the engraving is manufactured by the Morris Machine Works, of Baldwinsville, N. Y. The engine is the Westinghouse standard, made by the Westinghouse Machine Company, of Pittsburgh.

Albany Notes.

THE Wagner Palace Car shops at East Buffalo are very busy, every department being crowded with new work and repairs on old. Two of the finest cars ever sent out of the shops will soon be ready for inspection. One is for President Bliss, of the Boston & Albany, and the other is for President Depew, of the Central-Hudson. The shops are at work on two fine state-room cars, a class that are rapidly growing in popularity, and which are to be made a feature of the Central for the Chicago Exposi-

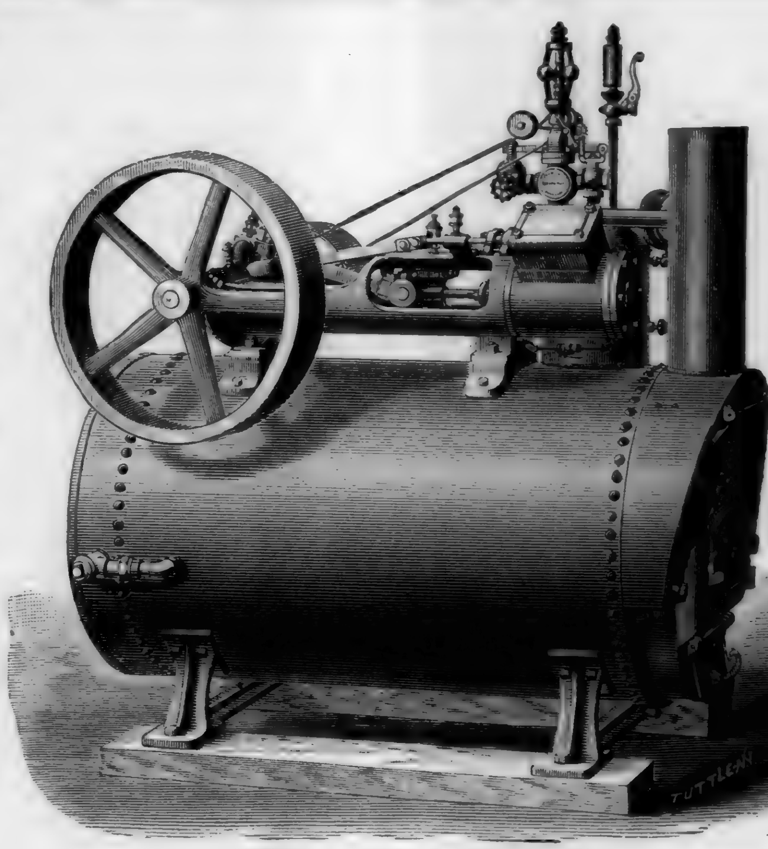
tion travel. There is now in hand in these shops also an order for thirty sleepers of the class known as "onyx columns."

THE Delaware & Hudson coach No. 53, on the Albany & Troy Belt Line, has been fitted with a system of ventilators that work upon an entirely new principle. By means of vanes on the outside of the roof a series of exhaust fans, propelled by the resistance of air when the car is in motion, forces the foul air from the interior of the car. The apparatus is the invention of W. S. Rogers, of Troy.

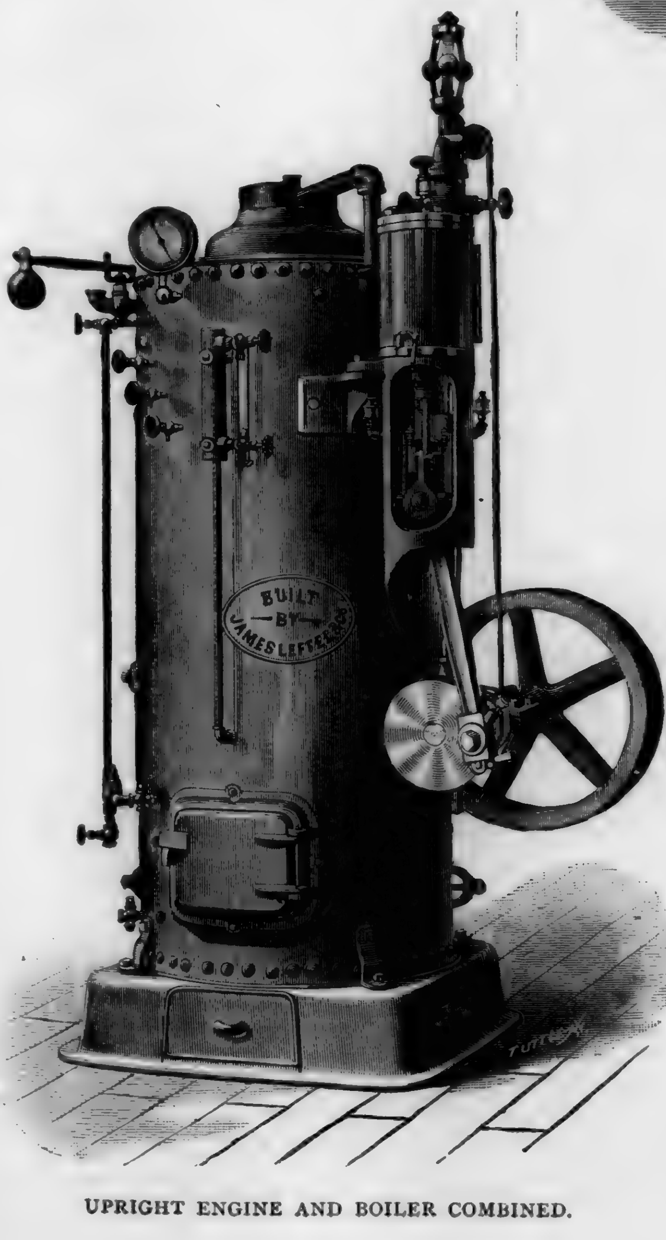
THE Albany street railroad (electric), after experiments with a hot-water heater, with furnace on the platform, has discarded it and returned to the old car stove. The inconvenience and often positive discomfort of this arrangement, however, will lead to further experiments. The man who invents a practical and cheap car heater will have a bonanza.

A BILL has been introduced in the New York Assembly providing that vehicles, except on railroads, passing over a public highway in the State, must have tires on the wheels 3 in. wide when the weight is between 2,000 and 6,000 lbs., and 4 in. in width when over 6,000 lbs. in weight.

THE railroad bills pending in the New York Legislature include an Act to require more complete fencing of roads, and the Railroad Commission bill, providing for the prohibition of grade crossings in the future. Both will probably fail this year.



PORTABLE ENGINE AND BOILER.



UPRIGHT ENGINE AND BOILER COMBINED.

Some Portable Engines.

THE accompanying illustration shows a semi-portable engine and boiler of the horizontal type. In this boiler the fire-box consists of a large cylindrical flue surrounded by water, extending the entire length of the boiler, in the front end of which is placed the furnace with a bridge-wall at back end of the grates, which are of unusual length, making a long furnace and ample grate surface. Back of the bridge wall is a combustion chamber, the entire diameter of the furnace flue, its rear end having a chamber extending upward for the return of the heated gases through a series of tubes, the length and diameter of tubes being properly proportioned to the size of the boiler. The rear end of the boiler is constructed with hinged door for the ready inspection and cleaning of that portion of the boiler; this part having a special improved fire-proof lining, which protects the head and retains the heat within the combustion chamber. The front end of the boiler has the usual fire-door and other appliances, and hinged doors permitting ready access to the ash-pit and smoke-box. The boiler is of steel.

The main frame of the engine is cast in one solid piece, and is of the class known as straight-line engine, with a center crank, and bearings on each side, which are of more ample proportions than customary. The cylinder end of the frame is turned accurately in a lathe, and the guides for the cross-head are bored out in exact line with the cylinder, making a concave surface to the guides, so as to insure the cross-head from any possible binding or heating on the sides. The cross-head is constructed with adjustable gun-metal gibs or followers. The cross-head with its pin, and the connecting rod, as also the crank shaft, are made of homogeneous solid cast steel. The cylinders are cast of carefully mixed iron, so as to insure the best results in regard to tenacity and density, as also the pistons and valves. The cylinders are covered with asbestos, with Russia iron jacket with brass band trimmings. The valve is the D slide valve, of proper proportions, adapted to the service and speed of the engines; the eccentric for operating the valve being arranged to fasten in position to crank-shaft with a cap-screw, having two holes for said screw in web of eccentric, so that by changing the screw from one hole to the other the engine is adjusted to run in the opposite direction. Each engine is supplied with throttle valve and safety governor, which insures the stopping of the engine in case of the breaking of the governor belt. The engine is supplied with a large, heavy fly-

wheel pulley on one end of the crank shaft, and a smaller pulley on the opposite end. The engine-frame is so made that it can be taken from the boiler at any time and placed on a stationary bed-plate.

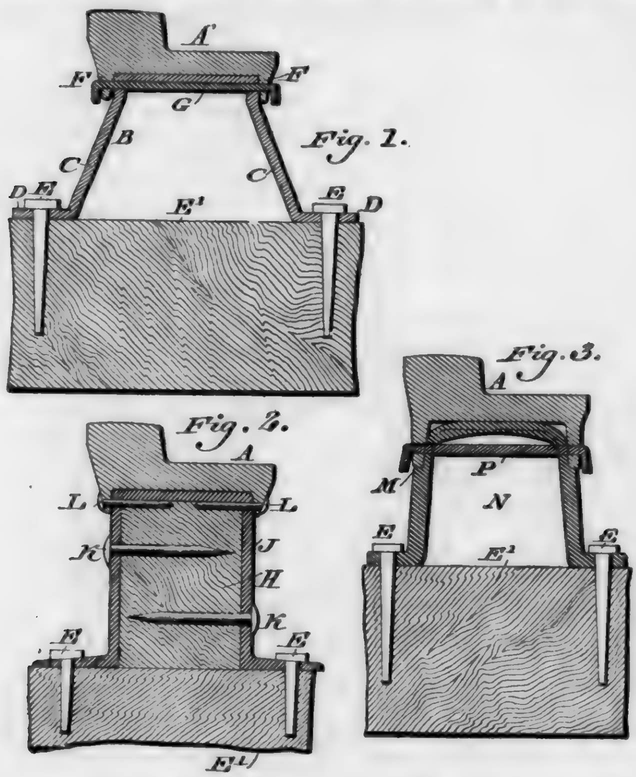
The second illustration shows an upright boiler and engine of a very convenient pattern, occupying a very small space. The engine is of the same type as the one described above, with the necessary changes to adapt it to the vertical type. This engine, detached from the boiler, would make an excellent wall engine for a small shop or a line of shafting. The boiler has the upper tube-sheet submerged, so that the entire length of the tubes is covered by water. This engine, like the horizontal one, is provided with an efficient governor and all necessary appliances.

These engines are made by James Leffel & Company, of Springfield, O.

Price's Street-Railroad Track.

THIS invention, which is covered by patent No. 469,392, issued to James M. Price, of Philadelphia, relates to an improved method of constructing street railroad tracks. In the drawings fig. 1 shows a section of a road embodying the invention; figs. 2 and 3 modified forms of the same.

Referring to the drawings, *A* designates a street rail, and *B* a chair of arched or angular shape, the latter being formed of either rolled, stamped, or cast metal, and having flaring sides *C*



PRICE'S STREET RAILROAD TRACK.

provided with horizontal feet *D*, extending outward from said chair, and adapted to be secured by the spikes *E* to a wooden or other cross-tie, *E'*.

The top of the chair is fitted closely to the under side of the rail, and both sides of the crown thereof are embraced by the depending flanges *F* of the rail, and are provided with openings, through which and other openings in the said flanges *F* are passed the metallic binding-straps *G* which pass underneath the under face of the crown of said chair, and have their outer ends bent so as to be held in place.

In the modification shown in fig. 2 a wooden sleeper, *H*, resting upon the cross-ties *E'* is inserted within a chair, *J*, which is of less thickness than that shown in fig. 1, so as to strengthen the same and thereby aid in supporting the rail *A* thereon. The sides of the said chair are provided with openings for the insertion of spikes or rails *K*, preferably cylindrical in shape, for binding the said chair to the sleeper. Passing through openings in the flanges of the rail *A* are the spikes, nails, or straps *L*, which are driven in or rest in grooves on the upper face of the wooden sleeper and directly beneath the under face of the crown of the chair. The feet of the chair are secured by suitable means to the cross-tie.

In fig. 3 is shown a section of a channeled chair having the shoulders *M* on its sides, on which rest the flanges *N* of the rail, which are lengthened and are of greater thickness than those shown in the other forms. The said chair is adapted to form a continuous passage or channel *N'*. A soft metallic strap, *P*, passing through the flanges of the rail and the sides of the arch above the shoulders, and having its outer ends hammered down outside the flanges, binds the rail and chair together, and spikes secure the feet of the chair to the cross-tie.

In the structure shown and described the holes or openings in the flanges and chair are either oblong, oval, or rectangular and of a greater length than height to provide for expansion or contraction of the construction due to heat or cold. In connecting the rails and channel-chairs broken joints are used, so that the ends of the chairs and the rails do not coincide.

The chair constructions herein shown are first rolled in lengths of from 20 to 40 ft. of their respective sections and then sawed into widths of from 3 to 5 in. except the joint-chairs, which rest upon the two cross-ties, and which should be from 12 to 24 in. long.

The strength of the arched longitudinal chair as first made is such that cross-ties may be entirely dispensed with and an excellent all-metallic structure had without sawing into chairs by resting this arched channel-rail system upon a tamped bed of Belgian block, broken stone, or its equivalent.

It will be seen that the various chairs herein described may be made of a channel bar bent into the shape indicated by suitable rolls or other devices, punched or drilled to form holes, as stated, and sawed transversely, those for the joints being double or treble the length of the ordinary chair.

Both the arched-chair and the arched-channel constructions are possessed of great strength and elasticity, and the latter breaking joints with the rails frequently fastened to it makes a very firm and smooth surface, preventing shocks at the joints.

Baltimore Notes.

THE operation of the Pittsburgh & Western Railroad has been consolidated with the Baltimore & Ohio management, thus carrying out the objects for which the Baltimore & Ohio purchased the control of the Pittsburgh & Western. It will be remembered that part of $10 000,000 of stock issued by the Baltimore & Ohio last fall was for the purchase of this road, which, with the Akron & Chicago Junction Railroad, opened last summer, constitutes the Baltimore & Ohio's new route to Chicago. A statement has been issued that it is desirable to operate the two railroads as one system, and the following officers of the Pittsburgh & Western have been appointed by order of President Oliver: J. T. Odell, General Manager; Frank Harriott, General Freight Traffic Manager; Charles O. Scull, General Passenger Agent; J. V. Patton, General Superintendent. Mr. Patton was formerly Superintendent of the Pittsburgh Division of the Baltimore & Ohio. The other appointees hold similar positions to those named in the Baltimore & Ohio service. The office of the General Superintendent will be at Alleghany City, Pa. The other officers will have their headquarters in Baltimore. The subordinates in the various departments were instructed to report to the new officers from March 15.

MESSRS. BARTLETT, HAYWARD & CO., of Baltimore, are building for the Columbian Fair the largest gas-holder in the country. It will have a capacity of 4,500,000 cu. ft. of gas. The diameter at the base of the structure will be 203 ft., and the height 230 ft., or 50 ft. higher than the Washington Monument in Baltimore. The gas-holder will be the type known as "telescopic," and will be provided with four hydraulic seals to admit of telescoping the four sections inside of one another. This is the first instance of four sections being applied in the construction of a gas-holder. In building the foundations and masonry of the brick tank in which the enormous vessel is to float, it will be necessary to excavate 57,000 cu. yds. of earth, to prepare 58,000 cu. ft. of concrete, and to erect brick masonry containing over 3,000,000 bricks. It will require nearly 8,000,000 galls. of water to fill the tank. The foundation and masonry of the tank are now completed, and upon the finishing of the water test, which is being made at present, the erection of the superstructure will be begun. The total pressure upon the foundations will equal 41,000,000 lbs., and the maximum pressure per sq. ft. will equal 5,000 lbs. The crown, or upper part of the gas-holder, will be spherical in form, and will be supported upon a permanent framework of timber erected upon the bottom of the tank. On account of the heavy strains imposed upon the gas-holder from wind pressure, the plating of the different curbs is extremely heavy, the maximum thickness in upper curb being ¾ in. All of the strains are transferred to and resisted by the guide framing. The guide framing surrounds the gas-holder entirely, and consists of heavy bridge girders connected by struts of lattice girders and diagonal braces, so that every member of the structure performs its assigned functions when at

tacked by the wind pressure. The total wind pressure when the gas-holder is inflated and in its highest position amounts to nearly 800,000 lbs. The basis of calculation for strains was formed on a pressure of 52 lbs. to the sq. ft. of vertical surface. The pressure equals a velocity of 100 miles per hour. All of the members of the guide framing will be connected by hot driven rivets. The heating and driving of rivets will be performed by the mechanics from small suspended platforms for the upper part of the structure, nearly 200 ft. above the ground. A set of stairs will extend from the bottom to the top of the structure, so that any part of the latter may be reached during heavy snow storms by the men in charge of the gas-holder. It will require 150 cars to transport the iron work from Baltimore to Chicago. It is expected to complete the work by the latter part of the present year, so that when the World's Fair is opened the gas-holder will be in complete working order, and will not only be a monument to Baltimore industry, but also a conspicuous representation of the energy of one of the most enterprising firms of this city.

AN agreement has been entered into between the Baltimore Belt Railroad Company and the Baltimore & Ohio Railroad Company, to take effect November 1 next. The Belt Company grants the Baltimore & Ohio the right at all times to maintain connection with its tracks and to use its stations and appurtenances for transporting and delivering traffic, and for the purpose of interchanging traffic with any other railroads which may hereafter form a connection with the Belt Line. The Baltimore & Ohio agrees to ship all its traffic passing through Baltimore over the Belt Line, excepting what is destined for stations of the Baltimore & Ohio on the water front of the city, or to and from Canton. Passenger traffic is to pay a *pro rata* on actual mileage, the distance from North Avenue to Camden Station being counted as one mile. Eight-wheel loaded freight cars are to pay $1.50 each, two four-wheel cars to count as one eight-wheel car. A minimum of $250,000 of traffic receipts is guaranteed by the Baltimore & Ohio; and when that amount is exceeded, the rate on the excess is to be reduced one-half. The Baltimore & Ohio agrees to keep in repair the tracks, stations, and appurtenances of the Belt Line and to pay all taxes. If other railroads use the Belt Line, they are to pay an amount in proportion to their wheelage.

THE Baltimore & Ohio has for some time been building to connect with the Virginia Midland Division of the Richmond & Danville at Fairfax Station. The line which is to connect the two systems is the Metropolitan Southern, which is to extend from Linden Station, a short distance from Washington, on the Metropolitan branch of the Baltimore & Ohio, to Fairfax. Through traffic for points on the Richmond & Danville will be run upon the Metropolitan Branch from Washington to Linden, when the connection is established, and thence to the South by way of Fairfax. It is thought that this connection led to the rumors of the acquisition by the Baltimore & Ohio of southern railroad systems, which President Mayer has denied.

THE Carlisle Manufacturing Company is building 300 hopper gondola cars of 60,000 lbs. capacity for the Monongahela River Railroad.

The Edwards Car Window.

THE accompanying illustration shows a car window devised by Mr. O. M. Edwards, of Syracuse, N. Y., fig 1 being a perspective view and fig. 2 a section through the window casing.

The window sash is connected by a band to a spring roller of sufficient strength to lift the sash. In place of the ordinary stops on the inside of the window are two compound stops, one at either end of the sash. These stops consist of a movable section or strip enclosed by a stationary casing, to which they are connected by pivoted links so arranged that the movable section is thrown upward and outward by a spring against the sash, thus holding it firmly against the outside stops, making a tight joint and preventing the rattling of the sash. This arrangement, it is claimed, will not only exclude air and dust, but will prevent the opening of the window from without, as any force

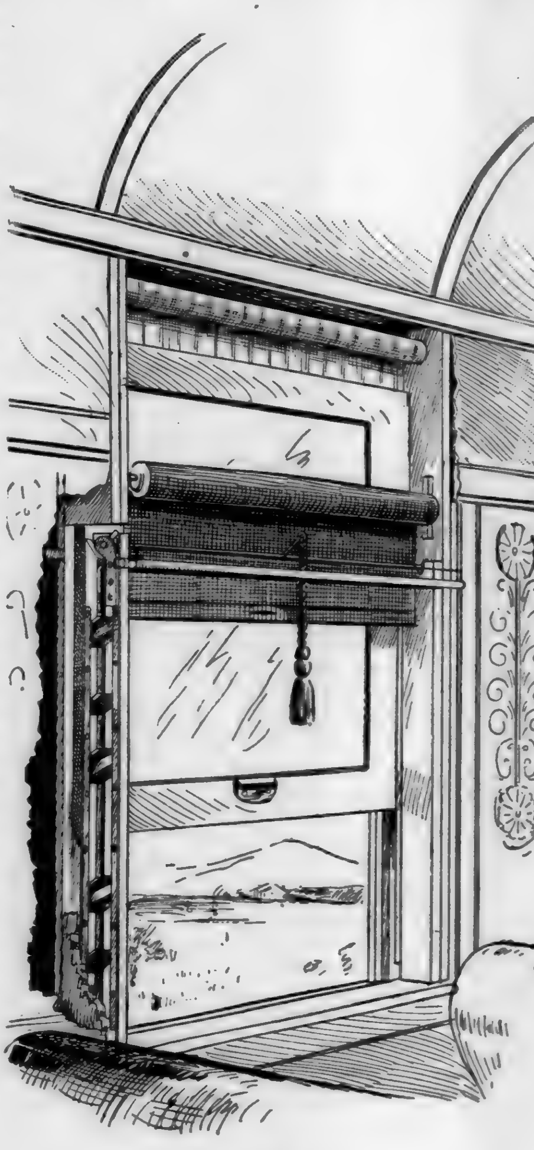


Fig. 1.

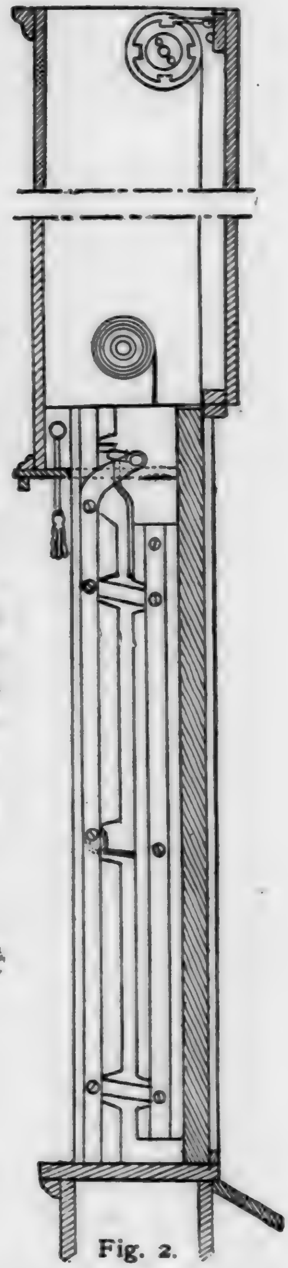


Fig. 2.

EDWARDS' CAR WINDOW.

applied for that purpose would only lock the sash more firmly. When the window is open the sash can be readily pushed down, as its friction will remove the pressure of the movable stops. These stops are connected by a rock-shaft provided with an arm midway between them, and at the top of the window, to which a tassel is attached. When it is desired to open the window all that is necessary is to pull downward upon the tassel, when the stops are lowered slightly by the rock-shaft and are thrown out of contact with the sash, thus leaving it free to be raised by the spring roller. Upon releasing the tassel the sash will be securely held at any point. When it is desired to close the window all that is to be done is to push it down by hand. The sash being held in place by the spring roller, it is not liable to fall, as the ordinary car window will sometimes do. It is claimed, moreover, that there is no chance of a failure to work, as the movable stops will give and take sufficiently to allow for any shrinking or swelling of the wood, thus preventing the sticking in wet weather, which is sometimes very annoying with the ordinary window; should any cinders or other matter become lodged inside of the sash they will fall out upon withdrawing the stops.

A trial of this window has been made on the Chicago & Alton Railroad, where a reclining chair car containing the largest sashes, 35 in. in width and weighing 30 lbs. apiece, has been fitted with this device. It has so far received general favor,

PERSONALS.

SAMUEL F. PRINCE, JR., has been appointed Superintendent of Motive Power of the Long Island Railroad.

M. B. CUTTER has been appointed General Superintendent of the Louisville, New Orleans & Texas Railroad.

FRANKLIN VAN WINKLE, Consulting Mechanical Engineer, has removed his offices to No. 126 Liberty Street, New York City.

JOHN F. WALLACE has been appointed Chief Engineer of the Illinois Central Railroad, succeeding L. T. MOORE, who has been assigned to other duties.

JULIAN A. HALL, recently on the Richmond & Danville Railroad, is now Engineer for the bridge works of Grant Wilkins in Atlanta, Ga., having charge of outside work.

LUCIUS TUTTLE, for some time General Manager of the New York, New Haven & Hartford Railroad, has been chosen Vice-President to succeed the late Edward M. Reed.

AMOS R. BARRETT succeeds the late William Smith as Superintendent of Motive Power of the Boston & Maine Railroad. Mr. Barrett was Master Mechanic of the Southern Division.

CHARLES S. PRICE has been appointed General Manager of the Cambria Iron Company, succeeding JOHN FULTON, who has been made General Mining Engineer of the Company.

E. L. MOSER, late Chief Draftsman, has been appointed Mechanical Engineer of the Philadelphia & Reading Railroad to succeed Mr. S. F. Prince, Jr., who has gone to the Long Island Railroad.

J. L. GREATSINGER has been appointed General Manager of the Duluth & Iron Range Railroad. He has been with the road for several years, at first as Master Mechanic and later as General Superintendent.

AT a meeting of the full Board of the Interstate Commerce Commission, held at its office in Washington, Saturday, March 19, HON. WILLIAM R. MORRISON was elected Chairman to fill the vacancy made by Judge Cooley's resignation.

ALFRED C. CHAPIN has been appointed a member of the New York Railroad Commission. Mr. Chapin is a lawyer by profession, has been Mayor of Brooklyn, and at present represents one of the Brooklyn districts in Congress.

CHARLES J. CARNEY is now Superintendent of Machinery of the Brooks Locomotive Works at Dunkirk, N. Y. He was recently Superintendent of the Dunkirk Engineering Works, and H. C. CROWELL succeeds him in that position.

CAPTAIN W. W. RICH has been appointed Chief Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Railroad in place of W. A. FISHER, who has resigned. Captain Rich had charge of the construction of the road, but retired some time ago.

WILLIAM E. ROGERS, recently Chairman of the New York Railroad Commission, has opened a law office at 120 Broadway, New York. Mr. Rogers also announces that he is prepared to examine and report on the financial or physical condition of railroads.

DANIEL W. SANBORN has been appointed General Superintendent of the Boston & Maine Railroad, assuming the duties performed by the late General Manager Furber. GEORGE F. EVANS succeeds Mr. Sanborn as Superintendent of the Southern Division.

J. W. LATTIG, formerly Superintendent of Telegraph of the Lehigh Valley Railroad, and more recently General Superintendent of the National Switch & Signal Company of Easton, Pa., is now General Superintendent of the Electric Secret Service Company, of New York.

JUDSON C. CLEMENTS, of Georgia, has been appointed a member of the Interstate Commerce Commission, WILLIAM LINDSAY, who was previously appointed, having declined the office. Mr. Clements is a lawyer of ability, and has served in the Georgia Legislature and in Congress.

F. W. BALDWIN has been appointed General Superintendent of the Central Vermont lines, succeeding JAMES M. FOSS, who has been appointed Assistant to the President. Mr. Foss has been connected with the road for 24 years, serving successively as Master Mechanic, Superintendent of Motive Power, and General Superintendent.

H. B. LA RUE is well known to many of our readers, and a number of them have probably heard that some time ago he was summarily arrested and placed in a private asylum. Those who have not heard the result will be glad to learn that he was promptly discharged from custody as soon as the question of his sanity could be brought before the proper court.

Mr. La Rue now has his turn, and has brought suit to recover heavy damages from certain parties concerned in the affair, and from some newspapers which published sensational articles in relation to it. His complaint in the suit is very full and carefully drawn, and presents apparently a strong case.

It is not the editor's business to pass judgment on a case that is now in court; but attention cannot be called too often to the ease with which a case of insanity can be made out against a man when there is a motive for doing so. Every man has some eccentricities of speech, habit and thought, and they are generally more prominent in a man of marked individuality—who is also apt to be really saner than the rest of us. It is very easy, under our present methods, for designing persons to take advantage of this; and for that reason we may hope that such men may be forced to make full restitution for the injury done by their schemes.

OBITUARIES.

WILLIAM SEAMAN, who died in Wilmington, Del., February 26, had been connected with the New York, Lake Erie & Western, the Norfolk & Western, and the Buffalo, Rochester & Pittsburgh railroads as an Engineer, chiefly in charge of bridge work. For several years past he had been connected with the Lobdell Car Wheel Works.

CAPTAIN TUNIS A. EGBERT, who died in Elizabeth, N. J., March 12, aged 50 years, was born on Staten Island, and had been for many years employed in the management of ferries in the waters about New York. He was for 27 years connected with the New Jersey Central ferries, and for four years Superintendent of the Hudson River ferries of the New York, Lake Erie & Western Railroad.

COLONEL CARSWELL MCCLELLAN, who died in St. Paul, Minn., March 6, served in the Engineer Corps during the War, and later was Engineer in charge of construction on the St. Louis, Vandalia & Terre Haute, the St. Paul, Minneapolis & Manitoba, the Northern Pacific and other roads. For some years past he had been in Government employ as a civil engineer on the Mississippi and other river work.

CHARLES J. VAN DEPOELE, who died in Lynn, Mass., March 18, was born in Belgium, but came to this country over 25 years ago. He was one of the first engineers to enter the field with an electric motor, and was notably successful. His first electric railroad was built in South Bend, Ind., and two years later there were 13 roads equipped with his motors, and the system had been applied to other purposes in many places. In 1888 the company which he organized was consolidated with the Thomson-Houston Company, and Mr. Van Depoele had since been with the last-named corporation as Engineer of its railroad department.

JOHN F. WINSLOW, who died at his home in Poughkeepsie, N. Y., March 10, aged 82 years, was born in Lyme, Conn., and many years ago became connected with the noted firm of Erastus Corning & Company. He was for a long time manager of the extensive iron works of that firm at Troy. He early saw the importance of the Bessemer steel making process, and with John A. Griswold and A. L. Holley he introduced the process into the United States, and for a long time controlled the patents here. Mr. Winslow and Mr. Griswold furnished the money to build Ericsson's *Monitor*, and it was their influence chiefly which induced the Government to try that ship.

Mr. Winslow was for four years—1863–1867—President of the Rensselaer Polytechnic Institute. For some years past he has practically retired from business, but has served as President of the Poughkeepsie Bridge Company.

ROSS KELLS, who died in New York, March 10, aged 52 years, had secured an excellent reputation as a mechanical engineer, and had had an extensive experience on various roads. He was for some time Master Mechanic of the Pittsburgh, Cincinnati & St. Louis Railroad, and was afterward Superintendent of Motive Power of the New York, Chicago & St. Louis. He left that line to take charge of the equipment of the New York & New England Railroad, and succeeded in filling a very difficult

position with much credit to himself and with benefit to the road. Five years ago he was appointed Assistant Superintendent of Motive Power of the New York, Lake Erie & Western, and three years later was promoted to be Superintendent of Motive Power. On the Erie Mr. Kells has been actively engaged in improving the rolling stock and in preparing to secure a greater degree of uniformity in the motive power, and had just reached a point where his labors promised to result in a notable success. Mr. Kells was widely known and popular, and his death at a comparatively early age will be much regretted.

Colonel and Brevet Major-General George W. Cullum, who died in New York, February 29, aged 83 years, was born in New York, entered the Military Academy in 1829, was graduated in 1833, and promoted to the Engineer Corps. From 1848 to 1855 General Cullum was Instructor of Practical Military Engineering at the Military Academy, except during two years, when he traveled abroad on sick leave. In 1853-54 he constructed for the Treasury Department the Assay Office in New York, after which he was employed for five years on fortifications and improvements in Charleston (S. C.) Harbor and superintended works at New Bedford, Newport, New London and New York. On November 1, 1861, General Cullum was appointed Chief Engineer Officer of the Department of the Missouri. He was Chief of Staff to General Halleck while the latter was in command of the Department of the Missouri, and also while he was General-in-Chief of the armies. He directed engineering operations on the Western rivers, was for some time in command at Cairo, and was engaged as Chief Engineer Officer in the siege of Corinth. This is but a brief summary of the services of this distinguished officer before and during the War. He received brevets of Colonel, Brigadier-General and Major-General in March, 1865, for his faithful, meritorious and distinguished services during the War, was mustered out of the Volunteer Service in September, 1866, and attained the grade of Colonel of Engineers in 1867. In 1874 he was retired from active service. General Cullum was of cultivated literary tastes. He was the author of "Military Bridges with India Rubber Pontoons," "Register of Officers and Graduates of the United States Military Academy," a translation of Duparcq's "Elements of Military Art and History," "Systems of Military Bridges of the Campaign and Engineers of the War of 1812-15 against Great Britain," "The Struggle for the Hudson," during the American Revolution, in "Narrative and Critical History of the United States," and numerous historical, geographical and biographical papers. He was a delegate to the Conference of the Association for the Reform and Codification of the Law of Nations, held at Cologne, Germany, in August, 1881, and to the International Geographical Congress at Venice, in September, 1881. He had been Vice-President of the American Geographical Society since 1874, and of the Geographical Library Association of New York City since 1880. After General Halleck's death, General Cullum married the widow of his old chief. By his will he gives a large sum for a memorial building at West Point.

PROCEEDINGS OF SOCIETIES.

American Institute of Mining Engineers.—At the Baltimore meeting the following officers were chosen: President, John Birkinbine; Vice-Presidents, Thomas M. Drown, David T. Day and John Stanton; Secretary, Dr. R. W. Raymond; Treasurer, Theodore D. Rand; Managers, H. L. Hollis, George W. Goetz and Charles Kirchhoff. Mr. Birkinbine receives the unusual honor of a second term as President.

National Electric Light Association.—At the recent convention in Buffalo, N. Y., the following officers were elected for the ensuing year: President, James I. Ayer; Vice-Presidents, E. A. Armstrong and C. H. Wilmerding; Secretary, George F. Porter.

It was decided to hold the next convention in St. Louis, in February, 1893.

American Society of Civil Engineers.—At the regular meeting, February 17, a paper on the Holland Dikes, by William Starling, was read and discussed at considerable length.

At the regular meeting, March 2, the Secretary read a paper by Mr. E. Kuichling on Loss of Head from Passage of Water through a 24-in Stop-valve. The paper gave the results of some very carefully made experiments. It was discussed by members present.

The following candidates were declared elected:

Members: David M. Andrews, Lock Three, Ala.; Dr. Charles B. Dudley, Altoona, Pa.; Roberto Gayol, City of Mexico; Justus H. Grant, Rochester, N. Y.; H. C. Lowrie, Denver, Col.; George F. Swain, S. E. Tinkham, Boston; James Duane, New York.

Associate Members: L. W. Goddard, Grand Rapids, Mich.; Henry H. Kerr, Fort Worth, Tex.; Albert Carr, New York.

At the regular meeting, March 16, Mr. Desmond Fitzgerald read a paper on the Boston Water Works, which was illustrated by a number of photographs. The paper was generally discussed by the members present.

New England Railroad Club.—The annual meeting was held in Boston, March 9, when the reports presented showed that the Club has now 192 members and is in a prosperous condition.

The following officers were elected: President, F. M. Twombly; Vice-President, John T. Chamberlain; Secretary and Treasurer, F. M. Curtis. These officers are all re-elected.

A discussion on Freight Car Trucks followed, which was opened by Mr. F. D. Adams and continued by other members present. In the course of the discussion the Fox pressed steel truck was described.

Northwestern Track & Bridge Association.—The annual meeting was held in St. Paul, Minn., March 11. The reports showed an increase in membership and also in interest in the meetings. The following officers were elected: President, John McMillan; Vice-Presidents, W. S. Darby and H. A. Buel; Secretary, James McCutcheon; Treasurer, J. Copeland.

New York Railroad Club.—At the regular meeting, March 17, there was a large attendance. A paper on Track, by Mr. Benjamin Reece, was read and a short discussion followed. Mr. D. M. Brady then read a paper on the Fox Pressed Steel Truck for Freight Cars. This was also discussed, and some notes of experience with freight trucks were given by members present.

Michigan Engineering Society.—The thirteenth annual meeting was held in Grand Rapids, January 20 and 21. A number of technical papers were delivered, and the following officers were elected: President, J. H. Forster, Williamston; Vice-Presidents, George L. Wells, Grand Rapids; Colonel Muenscher, Manistee; George S. C. Pierson, Kalamazoo; Secretary and Treasurer, F. C. Hodgman, Climax; Directors, Dorr Skeels, Grand Rapids; George E. Ames, Grand Rapids; William Appleton, Ann Arbor; Guy H. Carleton, Sault Ste. Marie; J. K. Yocum, Chelsea; ex-President Davis and C. S. Dennison, Ann Arbor.

Illinois Society of Civil Engineers and Surveyors.—The annual meeting was held in Chicago, January 27, and continued for three days. The first day's sessions were occupied with the reading of papers and discussions, and with the report of the Special Committee on Preparation of a Relief Map of the State for the Chicago Exposition. On the second day the President, Professor A. N. Talbott, delivered his annual address, and in the afternoon the members visited the work in progress on the Exposition.

Among the papers read were Brick for Highway Culverts, by G. W., Gastman; Qualities of Water, by D. W. Meade; State Inspection of Bridges, by E. A. Hill, and a State Bureau of Engineering, by R. E. Orr.

The following officers were elected for the ensuing year: President, S. S. Greeley, Chicago; Vice-President, J. D. Stanford, Chatsworth; Executive Secretary and Treasurer, Samuel A. Bullard, Springfield; Recording Secretary, Charles M. Rickard; Executive Committee, A. N. Talbott, G. C. Rossiter and D. W. Meade.

Virginia Association of Engineers.—The annual meeting was held in Roanoke, Va., January 15. A new constitution for the Society was proposed and considered. A number of papers were read and discussed by the members present.

The following officers were elected for the ensuing year: President, Clarence M. Coleman; Vice-President, J. H. Wingate; Directors, M. E. Yeatman, J. E. M. Humphreys, W. E. Anderson and C. G. Cushman; Secretary and Treasurer, J. R. Schick.

New Jersey State Road Convention.—This Convention was held in Trenton, N. J., January 21, on a call issued by the State Board of Agriculture. There was an attendance of about 250 from all parts of the State. Mr. Edward Burrough, of Camden, was chosen Chairman. Papers were read on the

Value of Good Roads, by Dr. James C. McKenzie; on Practical Road Building, by Robert A. Meeker, and on Experience in Road Building, by Dr. C. B. Ripley; the last-named paper recommended the use of wide tires for all vehicles carrying heavy loads. Professor Haupt made an address on the Cost of Traction on Different Classes of Roads. Mr. Bacot described the method of constructing the Telford roads on Staten Island, and Mr. J. J. Owen made some remarks on construction and repair of common roads. Mr. Owen estimated that the proper improvement of existing roads in the State would cost on an average from $2,500 to $3,000 per mile.

A committee of eight was appointed to draw up a road law to be presented to the Legislature and resolutions in favor of improved road systems were adopted.

Canadian Society of Civil Engineers.—At the annual meeting in Montreal, January 13, the annual address of the President was read, showing that there are now 656 members, and that the Society is in a prosperous condition.

The elections for the new Council resulted as follows: President, John Kennedy; Vice Presidents, Thomas Monro, W. T. Jennings, P. Alexander Peterson; Treasurer, H. Hallis; Secretary, Professor C. H. McLeod; Council, Professor Bovey, Joseph Hobson, H. G. C. Ketchum, H. N. Ruttaw, P. W. St. George, C. E. W. Dodwell, H. I. Cambie, K. W. Blackwell, C. H. Keefer, H. D. Lumsden, F. N. Gisborne, Alan Macdougall, I. D. Barnett, E. A. Hoare, F. C. Gamble.

The Gzowski Medal was awarded to D. H. Keeley, for his paper on Developments in Telegraphy. The resident members in Montreal entertained their visiting brethren at a conversazione in the new work-shop building of McGill College, which was a brilliant social gathering.

Engineers' Club of Minneapolis.—At the annual meeting, held January 7, the following officers were elected: William A. Pike, President; W. W. Redfield, Vice-President; Secretary and Treasurer, F. W. Cappelen; Librarian, A. B. Coe; Member Board of Managers of the Association of Engineering Societies, Elbert Nexsen.

Technical Society of the Pacific Coast.—At the annual meeting in San Francisco, January 15, the following officers were elected: President, John Richards; Vice-President, Luther Waggoner; Treasurer, George F. Schild; Secretary, Otto Von Geldern; Directors, H. C. Behr, George W. Dickie, W. R. Eckart, C. E. Grunsky and A. Schierholz.

Mr. Richards is a mechanical engineer; Mr. Waggoner, a mining engineer; Mr. Von Geldern, a civil engineer, and Mr. Schild a naval architect, showing that the membership of the Society is pretty well distributed.

Civil Engineers' Society of St. Paul.—At the regular meeting, March 7, John Blodgett, H. S. Crocker, and David Curtin were elected members.

Mr. C. F. Hollingsworth read an interesting paper on the Yellowstone National Park.

Engineers' Club of Philadelphia.—At the regular meeting, February 20, after some discussion on the advantages of a large building for the joint use of the various engineering and technical societies of Philadelphia, it was resolved, on motion of Mr. Carl Hering, that a committee of five be appointed to confer with other societies on the advisability of erecting a large building for their joint use.

The Tellers of Election reported the following candidates elected to membership: D. P. Bruner, Walter C. Kerr, Paul A. N. Winand, Joseph C. Wagner, Henry L. Butler, Thomas Earle, Herbert P. White, Thomas Willis Fleming.

A memorial of R. H. Lee, which had been prepared by Mr. Trautwine, was presented, and it was directed that same be incorporated in the minutes and printed in the *Proceedings*.

Mr. A. Saunders Morris read his paper on Limitations of Electric Power Transmission, which was discussed by Mr. Carl Hering, and Mr. Morris replied to a number of questions raised.

A translation of M. Bazin's paper on Flow of Water over Weirs, by Arthur Marichal and John C. Trautwine, Jr., was presented in abstract.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting of the society was held in Pittsburgh, on March 15. The meeting was devoted to discussing Mr. Metcalf's paper on Smoke, read at the February meeting.

Mr. J. W. Langley opened the discussion by stating that one side of the smoke question is sometimes overlooked: that certain industries produce smoke necessarily because of the requirements of the material which is being treated. In good practice steel furnaces do not produce any large amounts of smoke; puddling furnaces, coke ovens and household fires are large producers of smoke. Next to these last is undoubtedly boiler fires—probably in Pittsburgh they equal all other causes of smoke combined, and it is to them that the coming inventor needs to direct his attention. The mechanical stoker can only be used in large establishments; small ones cannot afford them, and it is from the small ones collectively that the greatest part of the smoke comes. A smoke-laden atmosphere has one evil effect, and that is that it is mentally depressing; that smoke is injurious to bodily health has never been proved by testimony.

Dr. Daly spoke for the Ladies' Health Association upon the injury of smoke on the lungs and air passages.

Several characters of smoke consumers were then described by their representatives. After a lengthy discussion engaged in by many of the members, a Committee on Smoke Prevention was appointed, consisting of Messrs. Dempster, Johoson, Hyde, Scaife and Langley.

Western Society of Engineers.—At a meeting held in Chicago, March 2, a committee was appointed to confer with similar committees from the Chicago Electrical Society and from the Western Society of Architects. The intention is that the three committees shall complete an organization having for its object the equipment of a museum of mechanical arts with testing rooms and other facilities for teaching in connection with the Chicago University. It is understood that if the building is provided the University will assume the cost of running the school. The amount needed is about $250,000, and a large part of this has been promised.

Civil Engineers' Club of Cleveland.—At the annual meeting, March 8, the reports of the retiring officers were presented. The Secretary showed an increase of 11 members, and 14 papers were read at the meetings. The Treasurer's report showed the finances to be in good condition. The Librarian reported an increase in the number of books, and also an arrangement with the Case Library Association giving members the use of valuable reference books.

The Programme Committee presented three interesting reports: one by Professor C. S. Howe on Recent Advancement in Physics; one by F. A. Coburn, on Recent Works of Architecture, and one by A. Mordecai, on Railroad Engineering.

The following officers were elected: President, Walter P. Rice; Vice-President, Albert H. Porter; Secretary, Charles S. Howe; Treasurer, C. P. Leland; Librarian, Charles H. Benjamin; Directors, C. H. Strong and G. A. Hyde.

The retiring President, Mr. J. L. Gobeille, then delivered the annual address on the Financial Status of the Engineer.

Engineering Association of the South.—The regular March meeting was held at the Young Men's Library Association Hall, Atlanta, Ga., March 11, President A. V. Gude, of Atlanta, presiding, with 20 members and about 30 visitors present. The non-resident members and invited guests from Kentucky and Tennessee reached Atlanta Thursday evening by a special train placed at their disposal by Major J. W. Thomas, President of the Nashville, Chattanooga & St. Louis. The trip from Chattanooga over the Western & Atlantic was made in charge of Mr. Hunter McDonald, Resident Engineer of the road, and the train made numerous stops to inspect the extensive improvements on track and bridges now being carried on. These improvements comprise the building of between 20 and 30 iron bridges, the rebuilding of a large proportion of the masonry for them, the reballasting of a considerable portion of the road-bed and the beginning of the relaying of the track with heavy steel rails, which is to be gradually extended.

Friday morning was spent in visiting the principal points of interest in the city, the greater amount of the time being devoted to the inspection of the new plant of the Electric Lighting & Power Company.

At the meeting a communication was received from Mr. Octave Chanute, transmitting a prospectus of the organization of the International Congress of Internal Water-ways, and extending an invitation to attend the fifth annual meeting of this congress to be held in Paris, France, beginning on July 21.

The following were elected:

Members: Edward B. Cushing, Houston, Tex.; W. N. McDonald, Nashville, Tenn.

Juniors: Alexander H. Wood, Tracy City, Tenn.; W. T. Young, Nashville, Tenn.

Mr. Hunter McDonald then presented a paper on Steel Rails, which received very extensive discussion by Messrs. Lodge, MacLeod and Dudley. The paper gave the history, chemical analyses, rate of wheel wear, results of bending tests and of tensile tests of three steel-rails laid at different times on the Nashville, Chattanooga & St. Louis.

Mr. A. V. Gude presented a paper on the Granite Quarries of

Lithonia, Ga. The paper presented comparative results of the crushing strength of granite from the quarries at Richmond, Va., Stone Mountain, Ga., and Lithonia, Ga., and described fully the quarrying operations at Lithonia. The most interesting point brought out by the paper was the method of lifting a quarry or producing an artificial bed covering acres in extent by a single blast-hole, a method for producing an artificial bed for the floor of the quarries discovered at the Georgia quarries a few years since.

The paper was discussed by Messrs. W. C. Smith, J. K. Peebles, and T. P. Branch. Mr. Peebles presented a description of the Petersburg, Va., quarries.

Master Mechanics' Association.—Secretary Sinclair has issued a circular calling attention of members to the necessity of answering circulars of inquiry as promptly as possible.

The Committee on Compound Locomotives—the Chairman of which is Mr. George Gibbs, Mechanical Engineer, Chicago, Milwaukee & St. Paul Railroad—has issued a circular requesting members who are in position to do so to make comparative tests of compound locomotives if possible before the Convention. If they can comply they are requested to notify the Committee at once.

Master Car Builders' Association.—The Arbitration Committee requests suggestions from all interested as to changes which may be considered desirable in the rules of interchange.

The Committee on Standard Center Plates has issued a circular containing drawings of proposed standard center plates, both of malleable and of pressed steel, and requests comments from members on the proposed plans. This Committee has also submitted designs for standard stake-pockets of two sizes, with the same request.

The Committee on Cast-Iron Wheels has issued circulars making inquiries as to the number of points in relation to the manufacture and service of such wheels.

The Committee on Joint Inspection also wants information as to the interpretation of a number of points in the rules, and suggestions as to changes which may be needed.

The Committee on Standards has issued several circulars, the object of which is to secure information from members as to the extent with which railroad companies generally are complying with the standards of the Association.

NOTES AND NEWS.

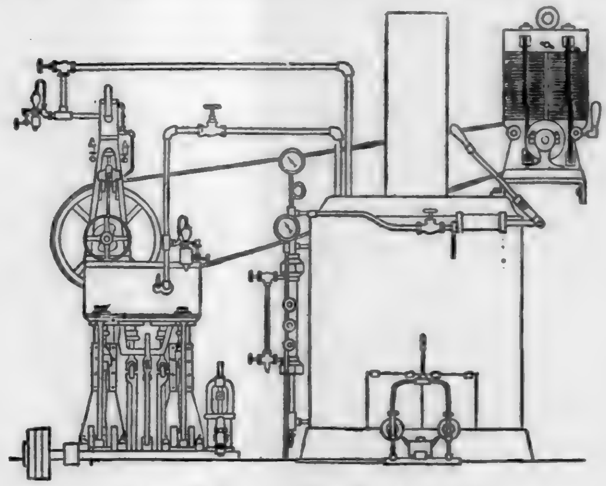
Double Nozzle for Tangential Water Wheels.—The Pacific Iron Works in San Francisco furnish the accompanying drawing of a recently designed double nozzle for tangential water wheels, constructed as nearly as possible to provide for the acceleration of approach, and also for application of the

NOZZLE FOR IMPACT WATER WHEELS.

streams in such relation that they do not interfere one with the other. There is also the provision of independent control for each nozzle besides the common gate in the main supply pipe. For the rest the drawing needs no explanation, showing as it does all parts clearly, and in correct proportion.—*Industry, San Francisco.*

A Small Electric Light Plant.—The steam yacht *Cygnet* is said to be the smallest vessel ever lighted by electricity from its own plant, and was an endeavor on the part of its owners, the Shipman Engine Manufacturing Company, of Rochester, N. Y., to show how complete an equipment could be placed within the most limited space.

The vessel is 35 ft. over all and 7 ft. beam. The hull is planked with white cedar, copper riveted, and lined inside with cherry and white pine finished in oil. A Shipman oil-burning boiler supplies steam at 160 lbs. pressure to the two engines and donkey pump, all of which, together with the dynamo, are located in the cabin amidships. The main engine, which is a fore-and-aft compound engine having cylinders $3\frac{1}{2}$ and $6\frac{1}{2}$ in. with stroke of 5 in., operates its feed water and vacuum pumps by worm gear having a reduction of 4 to 1, and runs at 350 to 400 revolutions per minute. A high speed single engine is bolted to the cylinder head of the main engine as shown. This has a cylinder $2\frac{1}{2}$ in. $\times$ 3 in., and makes 500 revolutions per minute. Belted directly to the pulley of this high speed engine, and located on a bracket attached to the front of the cabin, is a $\frac{1}{2}$-kilowatt Edison generator, capable of supplying ten 16 C. P. incandescent lamps. The wiring was neatly done



YACHT ENGINE AND DYNAMO.

by Putnam, Gay & Company, of Rochester, who also arranged a search light so that when desired it can be thrown into circuit. By means of this light, it is said that the bottom of the lake can be readily seen in 40 ft. of water.

The *Cygnet* has a speed of 10 miles an hour, is fitted up with great care, and is a very comfortable craft.—*Electricity.*

Harveyized Rails.—Since August, 1891, two rails have been lying in the track of the Delaware, Lackawanna & Western Railroad at Scranton which have been treated by the Harvey cementation process, the idea being to have the top of the rail, which is exposed to wear, hard, while the balance of the rail remains soft and is not subject to danger from breakage. The following analyses give the carbon at different depths:

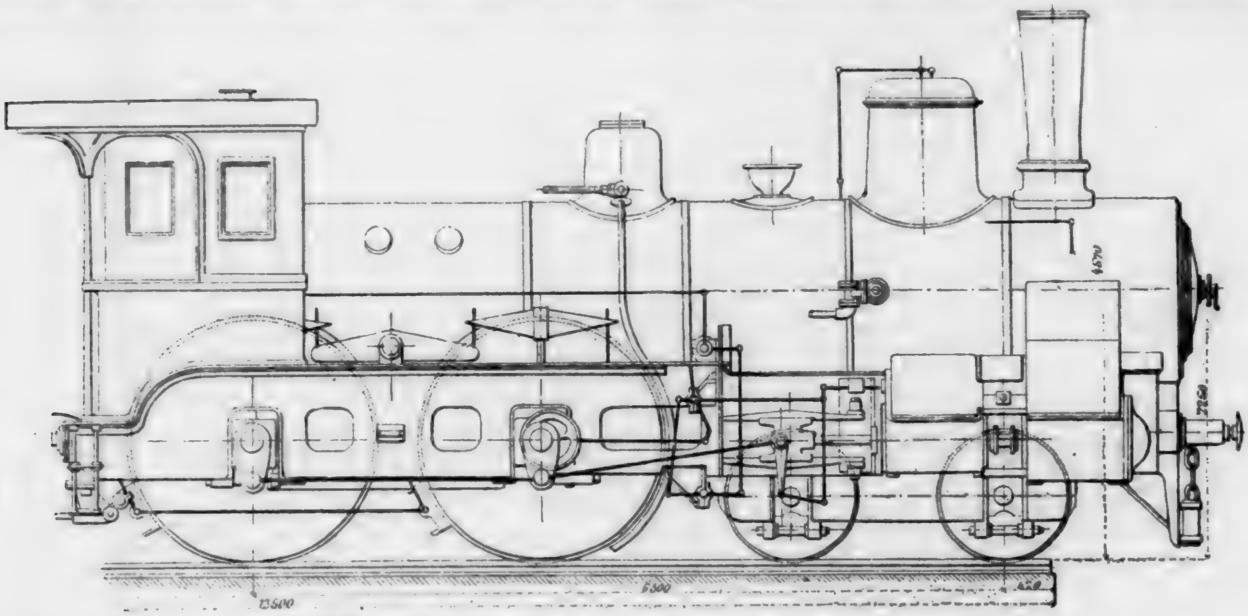
Depth. Inches.	No. 1 Rail.	No. 2 Rail.
$\frac{1}{16}$	0.76	0.76
$\frac{2}{16}$	0.42	0.42
$\frac{3}{16}$	0.33	0.31
$\frac{4}{16}$	0.30	0.30
$\frac{6}{16}$	0.30	0.30
$\frac{8}{16}$	0.33	0.30
$\frac{10}{16}$	0.30	0 27
$\frac{12}{16}$	0.30	0.28
1	0.27	0 26
$1\frac{4}{16}$	0.27	0.26
$1\frac{8}{16}$	0.27	0.25
Flange	0.24	0.27

The railroad officials report that the Harveyized rails show less wear and flow of metal than other rails subjected to service under the same conditions.—*Iron Age.*

A New Cement.—The *Revue Scientifique* notes that Mr. Takayama, a Japanese engineer, has been making use of a sand resulting from the decomposition of granite, which is found in large quantities in Japan. This sand, when mixed with lime, forms an excellent cement. Briquettes composed of 100 parts of sand and 10 parts of slaked lime, after two weeks' exposure to the air, showed a resisting power of 56 lbs. per sq.

in.; after six weeks' exposure, this was increased to 85 lbs. Immersed in water, the resistance, after 15 weeks, was 129 lbs. to the sq. in., showing a great increase.

A Hungarian Compound Locomotive.—The accompanying illustration, from the *Revue Generale des Chemins de Fer* shows a compound locomotive for express traffic recently built for the Hungarian State Railroads. As will be seen from the sketch the engine has four driving wheels connected and a four-wheel truck. The cylinders are outside and are placed in tandem, the low-pressure cylinder being in front and the high-pressure cylinder behind, the pistons of both being connected to the same rod. The low-pressure and the high-pressure cylinders are entirely distinct castings, and the connection between them is made by means of a steam pipe which serves as an intermediate reservoir. The valve motion is outside, and is of the Walschaert type, the same valve-rod moving the valves of both cylinders. The reversing gear is of the screw type, and can be closely adjusted. The throttle valve is so arranged that live steam from the boiler can be admitted to the low-pressure cylinder, and the reversing gear is also arranged so that when it is in full gear forward or backward, live steam enters the intermediate reservoir, and consequently the low-pressure cylinders. The boiler is of steel and has a very long fire-box, with an inclined grate for burning the coal which is ordinarily used on the Hungarian Railroads, and it is a sort of lignite. The frames are of steel and of the plate type ordinarily in use in Europe, and the truck frames are also of steel plate. The boiler is built for a working pressure of 165 lbs.



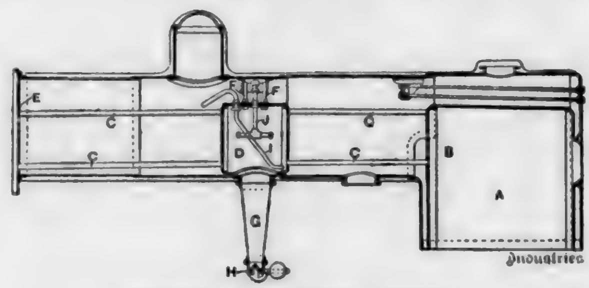
COMPOUND LOCOMOTIVE, HUNGARIAN STATE RAILROADS.

The high-pressure cylinders are 0.370 m. (14.57 in.) and the low-pressure cylinders 0.550 m. (21.65 in.) in diameter, both being 0.650 m. (25.58 in.) stroke. The ratio is 1 : 2.20. The driving-wheels are 2 m. (6.56 ft.) in diameter, and the truck wheels 1.05 m. (41.33 in.). The total weight of the engine ready for service is 119,900 lbs., of which 61,500 lbs. are on the driving-wheels and 58,400 lbs. on the truck. The conditions which this engine was built to fulfill were that it should draw a train weighing 160 tons over grades of 0.67 per cent., having curves of small radius, at the speed of 37 miles an hour, and that with the same train on a level it should be able to reach a speed of 49 miles an hour. The weight on an axle was not to exceed 14 tons. One object of the design was to secure the greatest possible amount of grate surface on account of the nature of the fuel, and also to keep down the wheel base of the engine as much as possible. The distance between the driving-wheels is 2.40 m. (7 ft. 10.46 in.), and the distance between the center of forward driver and center of truck is 3 m. (9 ft. 10 in.

Locomotive Slide-Valves below the Cylinders.—A correspondent of the *Practical Engineer* writes to that paper: "In your valuable journal, I notice a reference is made to the plan adopted by Mr. Holden, of the Great Eastern Railroad, of placing the slide-valve underneath the cylinder; and as hundreds of locomotives have been built under my instructions with valves fixed in this way, it may, doubtless, be of some interest to many of your readers to know that my experience fully confirms the advantages which are claimed on behalf of this arrangement. Indeed, in my opinion, the plan cannot be too highly recommended. I have invariably found that plan to result in material improvement in economy over locomotives similar in other respects, but with slide-valves placed above the cylinder. In some cases this economy amounted to one-sixth, added to which the wear and tear of valves in Holden's arrangement is materially reduced, while the noisy purging-cocks can be done away with—a point, by the way, which accounts for a part of the economy. When I first introduced the arrangement I encountered much opposition, and all sorts of objections were made to the alteration. Nothing daunted, however, I continued to adopt the plan, and can now affirm that this simple change possesses, in my opinion, more value than all the patents that have been taken out during the last dozen years for improvements in locomotive engines."

The Webb Locomotive Boiler.—The accompanying sketch shows a design of boiler recently patented by Mr. F. W. Webb, Locomotive Superintendent of the London and Northwestern Railroad in England. This boiler was used in his large compound engine *Greater Britain*, which was described and illustrated in the January number of the JOURNAL.

As shown by the drawing, a combustion chamber is arranged in the barrel of the boiler between the fire-box and smoke-box tube plates so as to divide the boiler into two lengths. The general arrangement will be clearly understood from the illustration, which shows a boiler so constructed in longitudinal section. *A* is the main fire-box, and *B* its tube plate, from



WEBB'S LOCOMOTIVE BOILER.

which tubes *C* extend to a tube plate at one end of the combustion chamber *D*, and at the other end of which another tube plate has further tubes *C* leading to the smoke-box tube plate *E*. The combustion chamber *D* is secured to the barrel of the boiler by stays *F* riveted to angle irons. At the lower part of the combustion chamber is a conical tube, *G*, closed by a valve, *H*, and weighted lever, which latter can be operated from the foot-plate of the engine, so that any ashes collected in the tube *G* may be allowed to fall out when required. *I* represents a circulating tube, of which any number may be arranged, either as represented in the illustration, or in any other suitable manner. A pipe, *J*, is also arranged to be controlled by a suitable valve which may be worked from the foot-plate, and which pipe is provided with two branches, each terminating in a rose, so that when steam is allowed to escape from them any soot or ashes will be blown from the open ends of the tubes *C*.

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SOME copies of the number of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, are needed to complete our files. Any subscriber having a copy of that number which he does not wish to preserve will confer a favor on the publishers if he will send it to this office. For every such copy received a credit of *three* months on his subscription will be given to the sender.

THE House of Representatives has approved the report of the Naval Committee, which recommended that only one new ship should be authorized this year—an armored cruiser of the same class as the *New York*. It is understood that the Senate will amend the bill to provide for two more battle-ships in addition; but the disposition of the House seems to be to adhere to its recent action.

SOME valuable historical exhibits are promised for the Chicago Exposition, and if the plans announced are carried out, there will be an opportunity to study the development of railroad construction and machinery such as has never before been presented. There is now no doubt that the Department of Transportation will be one of the most interesting sections of the Exposition.

AN interesting feature of recent marine development is the revival of the sailing ship, which seems to be taking place, in spite of the reduction in cost of operating steamships. Some very large sailing vessels have lately been built, and have proved themselves very successful carriers. Some of them are provided with auxiliary engines for use in case of need; but even with these the sails are the main reliance, and the engines are entirely subordinate. For long voyages especially the sailing ship is still an important factor in commerce, and is likely to hold its place for a good many years to come as a carrier of heavy freight.

A BILL to authorize the use of electricity instead of steam for motive power on railroads is before the Massachusetts Legislature; and some of the railroad managers of that State are reported as prophesying that the change will be made in a few years. Some of these utterances seem to be too sanguine, when we consider that no motor has yet been shown capable of hauling heavy trains at a high speed over long distances. It is dangerous to predict too much in these days, however; and, in view of what has already been done, it seems altogether probable that such a motor may be invented and set at work within a few years.

THE New York Central & Hudson River Railroad Company has just completed a new draw-span in its bridge over the Harlem River at One Hundred and Thirty-fourth Street, New York, which is of peculiar construction. It is a lifting bridge—not a swing bridge—is double tracked, and is 93 ft. long. The tower which carries the lifting arrangement is 120 ft. in height. The bridge is raised by a double-cylinder hoisting engine, and there are two counterbalance weights of 45 tons each. The bridge can be raised or lowered in 20 seconds.

The new draw is immediately south of the old swinging draw-span. All the work upon it has been done without interrupting the passage of trains—a difficulty which will be appreciated when it is stated that some 300 regular trains a day pass over the bridge, besides all the switching trains to and from the Mott Haven yard.

THE very sensible suggestion is made that there should be at the Columbian Exposition a concentration of the exhibits of road machinery and material, and of all that relates to construction and maintenance of roads. Under the classification at present adopted, these exhibits will be divided up among the Transportation, Machinery, Manufactures, Mining and Agricultural buildings, and so scattered that the effect will be lost, and it will take time and trouble, even for one interested, to find it all.

The road question is one of very great importance, reaching almost every one of us either directly or indirectly, and the road exhibits ought to have a better place. The Exposition will give an opportunity for lessons in road making which ought not to be lost, but should be improved in every way possible.

NEW railroad building is not very active as yet, and, so far as it is possible to predict, it does not seem probable that the new track laid in 1892 will much exceed that of 1891. Long lists of new railroads in progress have been published, but most of them have not yet reached the stage of actual construction work, and are merely projected. Some have gone as far as preliminary surveys or final location, but the number on which actual grading or track-laying has been begun is comparatively few. There is some difficulty in raising money for new enterprises still; and the chances for any railroad "boom" this year are not great.

WHILE new building is somewhat slow, the demand for railroad equipment is active, and numerous orders for locomotives and cars are reported. The railroads generally seem to be increasing their rolling stock, as well as filling up the gaps made by the depreciation of the past two or three years when renewals have been postponed.

In the new orders for motive power there seems to be a notable increase in the number of locomotives built for suburban and other special service. This was to be expected from the increasing complexity of railroad business and the greater variety of special service required.

THE great bridge over the Mississippi at Memphis was to be opened for traffic on May 1 with appropriate ceremonies. It is a notable structure in itself, and is notable also as being the first bridge crossing the Mississippi below St. Louis. In some respects the conditions at Memphis were favorable to the building of a bridge, but in other respects they were not, and some serious problems were met and successfully solved by the engineers.

The Memphis bridge will probably remain the lowest bridge crossing of the river for some time to come. There has been some talk of a bridge at New Orleans, but it has not assumed definite shape as yet, and the difficulties in the way are very great.

THE Poughkeepsie Bridge over the Hudson, while it is an admirable structure from an engineering point of view, has not been a commercial success, and has not earned enough to pay interest on its bonds. This is largely due to the fact that it has had no good connections, and has been used only by one line of small traffic. The present prospect is that it will pass under the control of the Reading combination, and in that case its business may be largely increased, as a very considerable coal traffic may be carried over it.

THE building of the proposed light-house on the Outer Diamond Shoal, off Cape Hatteras, has been abandoned for the present, the contractors having given up the work owing to the difficulties caused by the shifting nature of the bottom and the changes which have occurred since the last surveys were made. Messrs. Anderson & Barr have constructed many difficult foundations, but they do not believe that this work can be carried through successfully under the conditions required.

IN his annual address to the American Railway Association, a portion of which is given on another page, President Haines makes a plea against compulsory legislation for the adoption of safety appliances, his argument being especially addressed to the case of automatic couplers. Mr. Haines bases his argument chiefly upon what has already been done by the Master Car-Builders' Association and by the Association over which he presides, and makes the claim that the adoption of a safety coupler has been accomplished, and that it is being brought into use as fast as circumstances will permit. He believes the best solution of the question is in the voluntary action of the railroad companies, and thinks that this will, in the course of the next two or three years, make legislation unnecessary.

In this address Mr. Haines has taken the only ground upon which opposition to compulsory legislation can be successfully conducted. If the railroad companies support the action of their representatives and show a disposition to carry their resolutions into effect, his argument will be effective; and such action on their part is the true and practical way to avert the passage of a law which they do not want.

THE bills providing for the adoption of a safety coupler are to be postponed for the present, if committee action is to be considered as any indication. Recently the Senate Committee having the bills in charge reported an amendment to the Interstate Commerce Law directing the Commissioners to collect information as to the number of automatic couplers in use and their pattern, the number brought into use during the year and other statistics bearing on this point. The information so gathered is to be reported to Congress, and will serve as the basis for future action. It is evident that the Committee believes more information to be necessary before Congress can properly decide on the question.

ONE of the features of the railroad exhibit at the Columbian Exhibition will be a historical collection of railroad tickets. The work of collecting and arranging this has been undertaken by Mr. George De Haven, the General Passenger Agent of the Chicago & West Michigan Railroad, who has given much attention to this subject in the past, and has already many valuable data. He invites correspondence with all interested in the subject, and will take care that any collections, documents, etc., loaned for the Exhibition will be carefully handled, preserved, and returned at its close.

THROUGH the efforts of a committee, of which Mr. William Toothe was Chairman, the Railroad Supply Men, to be in fashion with the other business interests, had a dinner at Delmonico's on Friday evening, April 22.

It was quite a notable gathering, and was presided over by General E. S. Greeley, as representative of the longest service in the supply trade.

The after-dinner speeches were entirely informal; following instructions from the Chair, they kept as far from the toasts assigned them as they could. Among those who spoke were Mr. J. B. Ecclesine, Colonel Green, Captain Tarr, Mr. David Dodd, Mr. Angus Sinclair and others. Colonel C. A. Moore very happily presented the hopes and desires of the promoters of the dinner, as an effort to bring into closer and pleasanter social relations those who in business were seeking the same lines of trade, believing that while "business was business," there was room for a little sentiment, and that a closer social life would not only make business relations pleasanter, but make life better worth living.

His remarks were so kindly received, that it was unanimously voted that Mr. Greeley should be Chairman, and appoint a committee to secure a permanent organization of the interests represented.

The guests were very delightfully entertained by Mrs. Sherwood in her inimitable whistling and by Mr. E. J. Bushnell in several songs. The occasion was altogether one to be remembered by those present with pleasure, and with a wish that it may not be the last of its kind.

THE USES OF ALUMINUM.

LIKE every new question, that of the use of aluminum has had to pass through various phases of discussion. In the first place, its value was greatly exaggerated, and we were assured that it was the "metal of the future," which was to supersede iron, steel, and brass for all constructive purposes. More recently the natural reaction has followed, and we have been told that, after all, the metal was of very little account for practical purposes. In this, as in the first case, writers who have sought to instruct the public have gone much too far.

The truth appears to lie between the two extremes. The great advantages of aluminum in its lightness, ease

of working, and some other qualities will give it a certain and important place, but its behavior under compressive and transverse strains is hardly such as to make it such an efficient substitute for steel in construction as has been claimed in some quarters.

Probably the greatest use of aluminum will be found in alloys with other metals. In combinations such as aluminum bronze and others it is giving us some valuable additions to our available metals, and much is hoped for from its use in small quantities with steel and iron. The experiments already made in this direction have accomplished much, and show that more is to be hoped for.

The high price of the metal has hitherto prevented its free use, but considerable reductions in this direction may be expected. No less an authority than Mr. Hunt, who has been one of the pioneers in the manufacture, assures us that a gradual reduction in price is probable as methods of reduction are improved ; but the full force of this will not be felt until the output and demand are expressed in tons, instead of pounds, as at present.

FAST TRAINS.

MUCH public attention has recently been given both in this country and abroad to the question of fast time on railroads. There has been considerable rivalry among railroad companies in running fast trains, and the question has been discussed at length in the public prints, both technical and popular. Comparisons have been made between the railroads of different countries, and claims of all sorts have been made for superiority in this respect by writers of different nationalities.

What the public is chiefly interested in, however, is what may be called the commercial speed of trains—that is, the time which a train makes between its terminal points. The average traveler who goes from Chicago to New York, for instance, cares very little, after all, when he is told that at certain points of the run the train on which he travels makes 60 miles an hour ; he is chiefly interested in knowing whether it will take him 20, 24, or 30 hours to reach his destination. The commercial speed is the point which will determine his choice of route.

This commercial speed may be increased either by increasing the actual speed or by omitting stops and shortening up delays. The latter is, in fact, the method most usual on long lines, and the extent to which it can be carried depends entirely upon the nature of the business, the amount of the through traffic, and the number of important stations between the terminal points. On a line like that between New York and Philadelphia, for instance, the number of through passengers is sufficient to support the through trains without assistance from the local business ; and there, accordingly, the greatest speed and the greatest number of fast trains are to be found.

The fast train question is, after all, chiefly a commercial one. The cost of running is the main point with a railroad company, and if high speed will attract business and bring in a satisfactory return it will be furnished. On those roads where the increase of the commercial speed pays, it will be increased with perhaps a very few exceptions, where an undue conservatism and the absence of competition combine to delay improvements ; but, as a rule, it may be said that whenever and wherever the traveling public is numerous and is willing to pay for 60 miles an hour or more, it will be carried at that speed.

CITY TRAFFIC.

THE question of handling traffic in cities is one of the most difficult and perplexing of those which the modern engineer has to answer. The tendency of the present is to concentration of population, and the rapid growth of our large cities leads to demands everywhere for better facilities for movement, which must be met. New York has had this question before it for years, and so far it has met with only a partial solution ; much the same may be said of Brooklyn ; Philadelphia has begun to discuss it ; Boston has reached the point of complete congestion of the existing surface lines ; and Chicago is trying to act under the spur, not only of the ordinary demands of the city, but also of the pressing necessity of providing some means for carrying the great number of people who are expected to visit the city next year at the time of the Exposition.

It must be confessed that what has been done so far is not at all a satisfactory solution of the question. Unfortunately a city is not made to order ; it grows up gradually, and by the time it is large enough to need some form of rapid transit there are many obstructions in the way. Vested interests in valuable property are to be considered, streets must not be obstructed, and a great variety of other considerations must be taken into account. New York is in most respects very favorably situated for the construction of rapid transit lines, and its elevated roads seemed for a time to serve its needs ; but in a few years they began to be considered insufficient, and the continued discussions and efforts to secure a better system are well known.

With all the improvements promised by cable and electric traction, the speed on surface street lines must necessarily be limited to such a degree as to make them unsuited for long distances and to confine them to a limited radius. That the road which is to serve a large city must be above or below the surface is generally admitted. The expense of construction, and to some extent popular prejudice, are against the underground line ; while, on the other hand, the interference with the streets, the obstruction of light and air and the damage to adjoining property are the objections likely to be raised to all elevated structures.

It is a case where no general rules can be laid down, and where the engineer must take each one by itself and meet as best he may the difficulties arising. They are sure to be great and to require his best efforts to overcome them. The actual construction will be, in most cases, the least difficult part of the problem ; the preliminary work and the overcoming of objections will be the serious part of the work. Probably in a majority of cases the solution will be unsatisfactory to the engineer ; for he will not be able to secure the best, but will have to be satisfied with such a compromise as contending interests and circumstances will permit.

There is another problem to which very little attention has yet been given, and that is the quick and economical handling and distribution of freight in cities. Our present methods of collecting and delivering freight are primitive enough, and are hardly an improvement over those of a century ago. Terminal improvements have been confined to the handling of freight at the railroad station ; the getting it to and from that point has been left apparently with very little consideration. Especially with small shipments, the delivery at the station in New York, for instance, may cost quite as much as the transportation to

Chicago, and may require more trouble, if not more time.

The passenger question has been so much more pressing that it has absorbed attention heretofore; but freight distribution much needs improvement and must receive it in time. This is a field open to engineers, and those who succeed in occupying it may be sure of a reward.

PRACTICAL RAILROAD INFORMATION.

As the series of articles on Practical Railroad Information, which, we have reason to believe, has been very acceptable to many of our readers, is now drawing to a close, it has been considered best to add another series, which will supplement and complete the first, and will present much that is new and interesting both to railroad officers and manufacturers.

It is well known that there is oft-times a great discrepancy between the results obtained from different chemists' work on the same sample, and the lack of some standard method that can be used to harmonize results obtained by different chemists is a very real difficulty. It has been hoped for a period of years by the chemists engaged in commercial work, if we are rightly informed, that some of the learned societies would recommend standard methods. This want is very great in the steel trade, and also is a constantly growing one in the cases of other manufactured products. The different results obtained by different chemists are believed to be, in large part at least, due to the chemical method. Of course bad manipulation or working on samples which differ, or the use of impure chemicals, may contribute to the uncertainty between chemists, but it is generally believed that the method is the most important of the variables.

In view of this state of affairs, and also in view of the failure of all the chemical societies to recommend standard methods, we have made an arrangement with Dr. C. B. Dudley and F. N. Pease, Chemist and Assistant Chemist of the Pennsylvania Railroad, and authors of the series of articles above referred to, for a complete *exposé* of the methods in use in the laboratory of that corporation. These will give in detail the methods exactly as they are used, so that any one possessing ordinary chemical knowledge will be able to use the method as it is used in the Pennsylvania Railroad Laboratory.

We understand from these chemists that they expect to make these methods part of the contracts on which the materials examined by them are to be purchased, so that in reality these will be in the commercial world, to a certain extent at least, standard methods. Other chemists who are called in to decide disputes will necessarily use the same methods, since they will be part of the contract on which the materials were furnished. It will, of course, be understood that these chemists do not claim that the method which they use and publish is the best one, or the only accurate one, or even the most accurate one, but simply the best that they can recommend at the present time; and they will only serve as standard, if we understand them rightly, until such modifications are made as may be suggested by other chemists, or by their own studies, and may prove themselves as giving better results.

If we are rightly informed, some of the standard methods now in use in agricultural experiment stations started much in this way; and there is little doubt that the printing of the methods above referred to will call a good deal of attention to the matter, notably in the case of those used in the analysis of steel. The first article will probably appear in the June number, and will be followed each month by an installment embracing about three pages of the JOURNAL. It is probable that the methods used in analyzing will appear first.

We understand that the two chemists above named are considerably encouraged to undertake this work by correspondence with a number of the leading commercial chemists in the country, and that they do it with a good deal of hesitancy, but are rather forced to it by the emergency in which they find themselves placed. They entirely disclaim any attempt to arrogate to themselves superior knowledge, or to force themselves into a position of prominence. The scheme is based entirely on the commercial necessities of the case, which have long been recognized.

NEW PUBLICATIONS.

HOW TO BECOME AN ENGINEER. By George W. Plympton. Science Series, No. 100. The D. Van Nostrand Company, New York; price 50 cents.

In this book an attempt has been made to define the term "Engineer," and the author's definition is a sufficiently comprehensive one, for he says: "Engineering is the science of employing the physical properties of matter to serve the purposes of mankind. It includes also the useful application of the different forms of Energy."

The main object, however, is to advise the student who intends to become an engineer how to make the best use of his time and to direct his efforts to the best advantage. To this end a sketch is given of the courses of various technical schools both in this country and abroad. The expressed opinions of several eminent engineers are also quoted at some length, the list including such names as those of the late A. L. Holley, the late Ashbel Welch, John B. Jervis, Coleman Sellers, and others, whose words are entitled to consideration, and whose advice may well be heeded by a student or a young engineer.

STATE RAILROAD COMMISSIONS AND HOW THEY MAY BE MADE EFFECTIVE. By Frederick C. Clark, Ph.D. The American Economic Association, Baltimore; price 75 cents.

This monograph is intended, as the author says, "to present a practical solution of some, at least, of the difficulties of the railroad problem, and to suggest a policy for the more efficient regulation and control of that most important of all our *quasi*-public industries."

The first part is devoted to a sketch of the growth and development of the State railroad commissions, and shows incidentally some of the difficulties involved in the present system, where one railroad may come under the jurisdiction of two or three different commissions with widely varying powers and differing policies. The second part is a discussion of the steps necessary to secure greater efficiency in the commission system.

Dr. Clark's suggestions for the improvement of the present system are the establishment of commissions in the States where none now exist, and the securing, as far as possible, of uniform laws to increase their efficiency. He also believes in co-operation between the State commissions and the Interstate Commerce Commission. He is a believer in the policy of submitting rates to regulation, and generally in increasing the authority of the commissions, especially in such matters as the inspection of roads and bridges, the investigation of accidents, and licensing the formation of new companies.

There are now in existence 34 State commissions, of which 17 have power to regulate rates, 13 have authority to supervise and advise only, and four are simply boards to assess railroad property for taxation. Eleven States and four Territories

have no commissions. The classification given above is a very general one, there being very considerable differences in the degree of authority given in each class.

While many, especially among railroad men, will differ with the opinions expressed in this book, all must admit that it is a useful one, and is of service in collecting and clearly stating the conditions of the question, and in showing the disadvantages of the present lack of anything approaching uniformity. The author is also clearly right in his appreciation of the importance attaching to the appointment of commissioners. The high standing and authority of the Massachusetts Commission has been much more due to the personal standing and force of its members than to the extent of its powers; for, under the law, it might have quickly become insignificant if made up of weak or inefficient men.

COSTA RICA. BULLETIN NO. 31 OF THE BUREAU OF THE AMERICAN REPUBLICS. Washington; issued by the Bureau.

This book of 150 pages is another of the excellent monographs issued by the Bureau of the American Republics, in pursuance of its design of collecting and putting in accessible shape information concerning the States of South and Central America. The present issue is in general form and design like those previously noticed; it contains a general account of the country; a historical sketch; much information about its soil, products, and people; a condensed account of the land laws; descriptions of the railroads and highways; full particulars of the postal arrangements, tariff laws, and similar matters; and lists of merchants, with some statistics as to imports and exports. It is a very convenient book for all who have business with Costa Rica or desire to extend their trade to that country.

The book is illustrated by a map and by a number of engravings from photographs of buildings, scenery, and points of interest.

ROAD CONSTRUCTION AND MAINTENANCE. *Prize Essays reprinted from the* Engineering Record, *selected by a Committee of Engineers.* Published by the *Engineering Record*, New York.

Some time ago the *Engineering Record* offered prizes for three essays on the construction and maintenance of highway roads. In response to this offer, a number of papers were sent in from which three were selected by a committee composed of three well-known engineers, Messrs. F. Collingwood, Edward P. North, and James Owen, who also pointed out five others as worthy of mention. The volume under consideration includes the three prize essays, with extracts from the others mentioned, with some brief comments and criticisms made by the committee.

There is just now a demand for literature on this subject, and the publication of these papers is timely. All of them contain some excellent suggestions, and, while naturally there are some things in each which are fairly subjects for criticism, they are on the whole worth a careful reading, and are an acceptable addition to the information which we already possess.

BRICK FOR STREET PAVEMENTS. *An Account of Tests made of Bricks and Paving Blocks, with a Brief Discussion of Street Pavements and the Method of Constructing them.* By M. D. Burke, C.E. Robert Clarke & Company, Cincinnati; price, $1.

A considerable part of this work was originally prepared as a report on the best material to be used in paving the streets of the village of Avondale, near Cincinnati. This required the testing of different kinds of material for paving, with results which are of general interest to all who are engaged in similar work. The tests included granite blocks, bricks, and paving blocks of various makes, and the results show that good brick will compare much more favorably with stone than is generally supposed.

Besides the account of the tests, there is a short discussion on street pavements in general and the materials best adapted for them, and of the best methods for building and maintaining municipal works generally, from the practical engineer's point of view. There is also some information as to the best methods of making, drying, and burning brick, and the best and most economical way of using them in paving.

The use of brick is far more economical than that of stone in many parts of the country, and the information given in this little volume is very acceptable.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. VOLUME VIII., 1891. Published by the Institute, New York.

These *Transactions* make a volume of 634 pages, which contains many valuable papers read at the 12 meetings of the year, including the annual meeting, with the discussions upon them. The subjects chosen by the various writers are both theoretical and practical, and some of the late important applications of electricity are included.

While some of the papers are of much value, the discussions are perhaps the most interesting part. It often happens, indeed, in this as well as in other associations, that a paper is worth more for the discussion it calls out than in itself. The friction of argument will sometimes bring out facts and opinions which are not presented in the formal paper.

The volume is handsomely printed and bound, and its contents are a certificate of the activity and strength of the Institute.

RECORD OF SCIENTIFIC PROGRESS FOR THE YEAR 1891. By Robert Grimshaw, Ph.D. The Cassell Publishing Company, New York.

This "Record" is intended to set forth briefly the most important discoveries and improvements of the past year not only in all the branches of engineering but in all the arts and sciences. It consists of a great number of brief notes classified under appropriate headings and covering a very wide range of subjects. The compiler has succeeded very well in condensing the information given into a very small space, and the amount of labor represented in the book is very considerable

Such a book as this defies criticism, for it is impossible for the critic to follow up all the different subjects, since no one man can possess the necessary knowledge. It has its uses as an index or directory to those who are in search of information on any special topic, and may also be of value to the general reader, who does not care to go too deeply into any one subject. Perhaps the best way to regard it is as a yearly supplement to an encyclopædia, helping to keep such a work up to date in these times of continual change.

The value of the book is considerably increased by the very full index which accompanies it.

THE IRON FOUNDER. *A Comprehensive Treatise on the Art of Molding.* By Simpson Bolland. John Wiley & Sons, New York; price, $2.50.

This book is in large part a record of practical experience in the foundry, which the author has decided to preserve and illustrate for the benefit of younger members of the trade. Some idea of the scope of the work will be given by the contents. Part I is a general introduction, describing the tools and appliances of a foundry, with some advice to those who are learning the business. Part II treats of Core Making; Part III, of Loam Molding; Part IV, of Dry-sand Molding; Part V,

of Green-sand Molding ; while Part VI gives a variety of useful rules and tables.

The work should be a very useful one in its department. The descriptions are generally clear and plainly written, and are supplemented and completed by many illustrations. The rules given are generally plain, and are accompanied by the reasons for them, so that the reader is not obliged to take them simply on trust, but can study them out for himself.

More space in proportion, perhaps, is given to the difficult problems than to the more simple and ordinary work. This is very frequently the case, and is a very natural course, though perhaps not always the best. The young molder who reads this book, however, cannot fail to learn something ; and the same remark will apply to his more experienced brother in the art.

NOTES AND EXAMPLES IN MECHANICS ; WITH AN APPENDIX ON THE GRAPHICAL STATICS OF MECHANISM. By Professor Irving P. Church, Cornell University. John Wiley & Sons, New York ; price, $2.

This book is intended as a companion to the author's "Mechanics of Engineering ;" it contains notes and practical examples designed to illustrate more fully the application of fundamental principles. Among the subjects treated are Center of Gravity ; Non-concurrent Forces in a Plane ; Motion of a Material Point ; Statics of Rigid Bodies ; Moment of Inertia of Plane Figures ; Dynamics of a Rigid Body ; Mechanics of Materials and Graphical Statics The appendix contains a number of notes on the Graphical Statics of Mechanism, accompanied by examples.

In preparing this book, the author has had the advantage of continuous experience in the class-room, which is no inconsiderable one in showing the needs of students and the methods best suited for their instruction.

The appendix is based on the well-known work of Professor Herrman, with some improvements suggested by this experience with students. The book will be found a useful addition to the list of text-books on Mechanics.

CONTOUR MAP OF THE UNITED STATES. Compiled under the direction of Henry Gannett, Chief Topographer, by Harry King, Chief Draftsman, of the United States Geological Survey. Washington ; issued by the Survey.

This admirably executed map has been compiled from the maps and charts of the Coast Survey, the Geological Survey, the Land Office, and the several State surveys which are available. It is on a scale of 1 : 2,500,000, or, approximately, 40 miles to an inch. The contour lines are drawn at elevations above sea level of 100 ft., 500 ft., 1,000 ft., 1,500 ft., 2,000 ft., and thence upward at each 1,000 ft. In compiling, wherever contour maps have been made from surveys, such maps have been generalized and reduced ; elsewhere the contours have been based on heights measured by railroad and other surveys.

State and county lines, water-courses and railroads are shown on the map. It is arranged so that it can be used in sheets or mounted as a large wall map.

Accompanying it is a map of the United States on a single sheet on a scale one-third that of the larger map, or 1 : 7,500,000. This shows contours, and, in addition, State lines and water-courses.

The clearness and beauty of these maps make them a treat to a draftsman's eye.

BREADSTUFFS IN LATIN AMERICA. Issued by the Bureau of the American Republics, Washington.

This pamphlet, which is Bulletin No. 35 of the Bureau of the American Republics, is compiled from official returns, and shows the amount of the trade in breadstuffs between the United States on the one hand, and South America, Central America, and the West Indies on the other. It has also a variety of information as to tariffs, freight rates, and similar matters.

THE FIRST INTERNATIONAL RAILWAY AND THE COLONIZATION OF NEW ENGLAND : LIFE AND WRITINGS OF JOHN ALFRED POOR. Edited by Laura Elizabeth Poor. G. P. Putnam's Sons, New York ; price, $3.

John Alfred Poor, who is called by his biographer a "hero of commerce," was for many years a prominent figure in Maine. A man of incessant activity, he worked for many years as an editor, a writer, and an advocate of projects for the development of his native State and its chief seaport. He was the first active advocate of the building of a railroad from Portland to Montreal, which was finally constructed as the eastern division of the Grand Trunk. When that was accomplished, he turned his attention to the European & North American Railroad, which he advocated "through good and evil report" until its success was assured, and he then turned his attention to the line to Rutland and Oswego, which was to draw to Portland the business of the lakes, and to make that city the leading port for Western trade. In this he failed, and the line was never built ; but it was not for want of effort on his part.

With all his work as an editor and business man, he found time to write some historical papers requiring considerable research. These, with the more important of his other writings, are collected in this volume. His biographer has written a sympathetic rather than a critical life, and the whole is published in a handsome volume of 400 pages.

TRADE CATALOGUES.

Drawing Instruments, Protractors, Scales, etc. Illustrated and Descriptive Catalogue and Price List. Theodore Alteneder & Sons, 939–945 *Ridge Avenue, Philadelphia.*

This catalogue shows a great variety of drawing instruments and draftsmen's material, and its descriptive matter gives incidentally many useful hints. Prices are fully given, so that a draftsman can find not only just what he wants, but also just what it will cost him to get it. It is a very useful catalogue for reference and frequent consultation.

Sectional Catalogue Relating to Steam Hot Blast Apparatus for Heating and Ventilating Large Buildings. The Huyett & Smith Manufacturing Company, 1400 *Russell Street, Detroit, Mich.*

This catalogue gives a fully illustrated description of the Smith system of mechanical heating and ventilation, which has been introduced with much success in a number of shops, churches, schools, and other large buildings. As described, it seems a very simple and practical system, and it has been pretty fully tested by experience.

Injectors. The Rue Manufacturing Company, Philadelphia.

This is an illustrated catalogue of the different styles of injectors made by the Rue Manufacturing Company. Most of them are already well known and widely used but the catalogue will be of service both to those who already use them and may want to increase their number, and to those who need injectors and ought to consider those offered here.

Patent Improved Steam Hammers. David Bell, Buffalo, N. Y.

This catalogue illustrates the special type of steam hammer made by Mr. Bell, which includes a number of improvements

devised and introduced by him. The pamphlet is very neatly printed and illustrated.

Tight Valves at Last. Catalogue of the Roy Valve Company, New York. Illustrated.

Engineering Specialties for Steam, Water, Gas, Oil, and Chemicals. A. Aller, 109 *Liberty Street, New York*

Tobin Bronze: its Qualities and Uses. The Ansonia Brass & Copper Company, 19 *Cliff Street, New York.*

A Locomotive Coaling Station: Illustrated Description. The Link Belt Machinery Company, Chicago.

Sight-feed Lubricator for Locomotive Cylinders and Air Pumps: Illustrated Catalogue. The Michigan Lubricator Company. Detroit, Mich.

CURRENT READING.

THE May number of HARPER'S MAGAZINE completes the 84th volume of that periodical, which has now attained quite a venerable age. Years, however, seem only to increase its vigor. Among the papers in this number are one on the Dakotas, in the series on the Northwest; a continuation of the illustrated article on the Danube, and an important illustrated article on the German Army. The usual excellent variety of stories, sketches, and other lighter matter is also included in the number.

The May number of the OVERLAND MONTHLY contains some well-illustrated articles. One, by J. T. Goodman, treats of the rapidly growing Raisin Industry; another treats of the California Floral Society; a third, and very interesting one, treats of the Famous Street Characters of San Francisco, past and present. A historical paper on the date of the first discovery of Gold in California seeks to settle that disputed question by reference to the documents of the United States Mint.

In recent numbers of HARPER'S WEEKLY the illustrated descriptions of the Columbian Exposition buildings are continued. Among other articles there are illustrated papers on the new lands recently opened to settlement; on Improving Common Roads; on the New York Board of Trade and Transportation, and other interesting topics.

The latest issues of the NATIONAL GEOGRAPHIC MAGAZINE include President Gardiner G. Hubbard's annual address, on the Evolution of Commerce—a thoughtful and interesting paper; General A. W. Greely's report on the Geography of the Air; and the Mother Maps of the United States, by Mr. Henry Gannett, of the Coast Survey.

The usual variety of short and readable articles is found in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for April, with two or three longer illustrated papers. Readers of almost every class will find something in this number to interest them.

A book on DYNAMOMETERS AND THE MEASUREMENT OF POWER, by Professor J. J. Flather, of Purdue University, is among the new works in preparation by John Wiley & Sons, New York.

The ECLECTIC MAGAZINE for April has an exceedingly good selection of articles from current English periodicals. The range of subjects is wide, and the papers are well chosen to show the general drift of English magazine writing at present. On this account only, without considering the value of the several articles, this magazine is well worth reading.

An Index to Volumes I to XL of the POPULAR SCIENCE MONTHLY is well advanced in preparation, and will be published in the course of the coming summer. The entire contents of the 40 volumes will be entered both by author and by subject in one alphabetical list, and the Index will have all the most approved features of the latest magazine indexes, besides some novel ones. The compiler is Mr. F. A. Fernald, of the editorial staff.

For April the editors of OUTING have presented a very attractive number, both in illustrations and reading matter. Almost every kind of sport finds its representative; there is some fiction also, and Lieutenant Bowen concludes his article on the Connecticut National Guard. This magazine has a field of its own, and fills it very acceptably.

Articles on Anthropological Work in Europe; on Cave Dwellings; on Folk-Lore, and on Herbert Spencer and the Synthetic Philosophy are included in the contents of the POPULAR SCIENCE MONTHLY for May, besides several others of minor importance.

The April number of MINERALS has articles on Our Tin Supply, on Feldspar, and several interesting shorter articles and notes.

The April number of GOOD ROADS continues Editor Potter's talk on Dirt Roads and Gravel Roads, with some more striking illustrations. Hon. John J. Ingalls writes on the Roads of the Western States; Hon. John W. Davis on those of Rhode Island; and Mr. Studebaker, of Indiana, discusses the question of who should build the country roads.

In the April number of the ENGINEERING MAGAZINE Mr. T. G. Gribble writes of the Lake Route from the West, and Professor Haupt discusses the question, Do Waterways Benefit Railways? Other articles are on Prospect Park, Brooklyn; the Pessimism of Modern Architecture; the New York Trade Schools; Municipal Government; Building a Railroad in the Southwest, and Making an Invention. Mr. Wisner renews his attack on the Engineer Corps, and submits an impracticable scheme for a Department of Engineering.

Among the subjects treated in CASSIER'S MAGAZINE for March are Ventilation of Engine and Boiler Rooms; Automatic Sprinklers; Steam Pumps for Fire Protection; the Alabama Iron Industry; the Production of Aluminum; Professional Certificates, and several other minor topics. The illustrations are generally good, giving the magazine an attractive appearance.

The Cleveland IRON TRADE REVIEW appears in a new dress, at the same time reducing its page to a more convenient size and adapting a neat cover. The REVIEW is an excellent paper, and its improved form indicates well-earned prosperity and a continued intention to improve.

The COMPASS for April continues the papers on Series of Numbers, and has short articles on the Slide Rule, the Transit and the Metric System.

In the second number of the JOURNAL OF THE UNITED STATES ARTILLERY there are articles on Sea Coast Guns and Steel Armor, by Lieutenant E. M. Weaver; Field Practice, by Lieutenant E. Russel, and the English Proving Ground, by B. C. Batcheller. There are also some translations and a number of short notes. The JOURNAL promises to be a valuable addition to professional literature.

A notable article in SCRIBNER'S MAGAZINE for May is on Rapid Transit in Cities by Thomas Curtis Clarke, the well-known engineer; a special reference is made to the difficulties which Chicago will encounter in this respect next year. Professor N. S. Shaler begins a series of four articles on Sea and Land; Paul Lindau describes Unter den Linden in Berlin as one of the great streets of the world; Jacob A. Riis continues the series on the Poor in Great Cities, and in the Historic Moments series the receipt of the first Message by Telegraph is described by John W. Kirk, who was with Professor Morse at the time.

BOOKS RECEIVED.

Administration Report on the Railways in India: Part II. By Lieutenant-Colonel R. A. Sargeaunt, R. E., Officiating Director-General of Railways. Government Printing Office, Calcutta, India.

Magnetic Observations on the Shores of the Adriatic in the Years 1889 *and* 1890, *under Orders of the Marine Section of the Ministry of War of Austria-Hungary. By Captain Franz Laschober and Lieutenant Wilhelm Kesslitz.* Issued by the *Mittheilungen aus dem Gebiete des Seewesens*, Pola, Austria.

Ninth Annual Report of the Board of Railroad Commissioners, State of Kansas, for the Year ending December 1, 1891. *George T. Anthony, Albert R. Greene, W. M. Mitchell, Commissioners; Charles S. Elliott, Secretary.* State Printers, Topeka, Kans.

Reports from the Consuls of the United States to the Department of State: No. 137, *February*, 1892. Government Printing Office, Washington.

Master Car-Builders' Association Arbitration Cases Nos. 1 *to* 110; *December*, 1888, *to February*, 1892. Issued by the Association, Chicago.

Soft Steel in Bridges. By Frederick H. Lewis. Philadelphia. This is a reprint of a very interesting paper read by Mr. Lewis before the Engineers' Club of Philadelphia, accompanied by the discussion as reported for the Club.

Twenty-third Annual Report of the Board of Railroad Commissioners of Massachusetts: January, 1892. State Printers, Boston. This report has already been noticed from the advance sheets.

Annual Register of Purdue University, 1891–93. Lafayette, Ind.; issued by the University.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending September 30, 1892. *S. G. Brock, Chief of Bureau.* Government Printing Office, Washington.

Proceedings of the Engineers' Club of Philadelphia: Volume IX., No. 2. Issued by the Club, Philadelphia.

Census of Canada, 1891. *Bulletin No.* 5, *Manitoba, the Northwest, and British Columbia. Bulletin No.* 6, *Dwelling Houses. Bulletin No.* 7, *Livestock in the Northwestern Territories.* Department of Agriculture, Ottawa.

Suggestions of the Interstate Commerce Commission in Reply to Arguments on Senate Bill No. 892 *to Amend the Act to Regulate Commerce.* Government Printing Office, Washington.

Transactions of the American Institute of Electrical Engineers: Volume VIII, 1891. Published by the Institute, New York.

Catalogue of Lafayette College, 1891–92. Issued by the College, Easton, Pa.

1. *University Extension and its Leaders.* 2. *How to Begin University Extension.* 3. *Horatio Seymour on Higher Education.* Issued by the University Extension Department of the University of the State of New York, Albany.

A TEN-WHEEL PASSENGER ENGINE.

THE illustration given herewith is from a photograph of a ten-wheel passenger locomotive built by the Schenectady Locomotive Works for the Chicago, St. Paul, Minneapolis & Omaha Railroad, and intended to haul the heavy express trains on that road. The engine has no special features, but is an excellent example of the latest standard practice.

The boiler is of steel, and is of the wagon-top pattern, the barrel being 56 in. in diameter. The horizontal seams are quadruple-riveted with a welt-strip inside. The circumferential seams are double-riveted. The fire-box is of steel and is $90\frac{1}{8} \times 40\frac{3}{8}$ in. inside, the depth being $57\frac{1}{4}$ in. at the front end and $54\frac{1}{4}$ in. at the back. The crown-sheet is stayed by crown-bars in the usual manner. The fuel is bituminous coal, and the grate of the rocking pattern. There are 240 tubes 2 in. in diameter and 12 ft. long. The heating surface is: Fire-box, 126.3 sq. ft.; tubes, 1,497.5 sq. ft.; total, 1,623.8 sq. ft. The grate surface is 25.5 sq. ft. The smoke-stack is 16 in. inside diameter, and the top is 15 ft. above the rail. The boiler is supplied by two Monitor injectors placed right and left. The usual working pressure of steam is 170 lbs.

The six driving-wheels are 64 in. in diameter. The driving-axle journals are $7\frac{1}{2} \times 8\frac{1}{2}$ in. The truck is of the usual pattern, with 30-in. wheels, the truck-axle journals being 5×9 in. The driving-wheel base is 11 ft. 6 in.; the total wheel-base, 21 ft. 7 in. The tires of the forward driver are plain, so that the total rigid wheel-base is only 5 ft. 11 in.

The cylinders are 18 in. in diameter and 24-in. stroke. The piston packing is cast-iron rings, and the Jerome metallic packing is used for the piston-rod and valve-stem. The steam-ports are $16 \times 1\frac{5}{8}$ in. and the exhaust-ports 16×3 in. The valves are the Allen-Richardson balanced valve; they have $\frac{7}{8}$ in. outside lap and $\frac{1}{16}$ inside lap. The greatest travel of the valve is $5\frac{1}{2}$ in., and the lead in full stroke $\frac{1}{16}$ in. The exhaust nozzles are single, $4\frac{1}{2}$, $4\frac{3}{4}$, and 5 in. in diameter.

The tender is carried on two four-wheel trucks of the Schenectady standard pattern, having channel iron bolsters, center-bearings front and back, with additional side-bearings on the back truck. The tender wheels are 33 in. in diameter, and the tender axle bearings $4\frac{1}{2} \times 8$ in. The tender frame is of iron. The tank has a capacity of 3,300 gallons of water, and $5\frac{1}{2}$ tons of coal are carried in the coal-box. The weight of the tender empty is 28,900 lbs.; loaded it is about 66,000 lbs.

The total length of the engine and tender is 54 ft. $5\frac{1}{2}$ in. The total weight of the locomotive in working order is 116,000 lbs., of which 91,000 lbs. are carried on the driving-wheels.

SOME CURRENT NOTES.

IT is now claimed that nickel-steel is especially well adapted for ship-building on account of its strength, which will permit the use of lighter plates. It is also said that when 3 to 5 per cent. of nickel is used the alloy will resist the corroding action of sea water, which is so injurious to ordinary steel plates.

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TEN-WHEEL PASSENGER LOCOMOTIVE, CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILROAD.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

BOOKS RECEIVED.

Administration Report on the Railways in India: Part II. By Lieutenant-Colonel R. A. Sargeaunt, R E., Officiating Director-General of Railways. Government Printing Office, Calcutta, India.

Magnetic Observations on the Shores of the Adriatic in the Years 1889 and 1890, under Orders of the Marine Section of the Ministry of War of Austria-Hungary. By Captain Franz Laschober and Lieutenant Wilhelm Kesslitz. Issued by the *Mittheilungen aus dem Gebiete des Seewesens*, Pola, Austria.

Ninth Annual Report of the Board of Railroad Commissioners, State of Kansas, for the Year ending December 1, 1891. *George T. Anthony, Albert R. Greene, W. M. Mitchell, Commissioners; Charles S. Elliott, Secretary.* State Printers, Topeka, Kans.

Reports from the Consuls of the United States to the Department of State: No. 137, *February*, 1892. Government Printing Office, Washington.

Master Car-Builders' Association Arbitration Cases Nos. 1 *to* 110; *December*, 1888, *to February*, 1892. Issued by the Association, Chicago.

Soft Steel in Bridges. By Frederick H. Lewis. Philadelphia. This is a reprint of a very interesting paper read by Mr. Lewis before the Engineers' Club of Philadelphia, accompanied by the discussion as reported for the Club.

Twenty-third Annual Report of the Board of Railroad Commissioners of Massachusetts: January, 1892. State Printers, Boston. This report has already been noticed from the advance sheets.

Annual Register of Purdue University, 1891–93. Lafayette, Ind.; issued by the University.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending September 30, 1892. *S. G. Brock, Chief of Bureau.* Government Printing Office, Washington.

Proceedings of the Engineers' Club of Philadelphia: Volume IX., No. 2. Issued by the Club, Philadelphia.

Census of Canada, 1891. *Bulletin No.* 5, *Manitoba, the Northwest, and British Columbia. Bulletin No.* 6, *Dwelling Houses. Bulletin No.* 7, *Livestock in the Northwestern Territories.* Department of Agriculture, Ottawa.

Suggestions of the Interstate Commerce Commission in Reply to Arguments on Senate Bill No. 892 *to Amend the Act to Regulate Commerce.* Government Printing Office, Washington.

Transactions of the American Institute of Electrical Engineers: Volume VIII, 1891. Published by the Institute, New York.

Catalogue of Lafayette College, 1891–92. Issued by the College, Easton, Pa.

1. *University Extension and its Leaders.* 2. *How to Begin University Extension.* 3. *Horatio Seymour on Higher Education.* Issued by the University Extension Department of the University of the State of New York, Albany.

A TEN-WHEEL PASSENGER ENGINE.

THE illustration given herewith is from a photograph of a ten-wheel passenger locomotive built by the Schenectady Locomotive Works for the Chicago, St. Paul, Minneapolis & Omaha Railroad, and intended to haul the heavy express trains on that road. The engine has no special features, but is an excellent example of the latest standard practice.

The boiler is of steel, and is of the wagon-top pattern, the barrel being 56 in. in diameter. The horizontal seams are quadruple-riveted with a welt-strip inside. The circumferential seams are double-riveted. The fire-box is of steel and is $90\frac{1}{8} \times 40\frac{3}{4}$ in. inside, the depth being $57\frac{1}{4}$ in. at the front end and $54\frac{1}{4}$ in. at the back. The crown-sheet is stayed by crown-bars in the usual manner. The fuel is bituminous coal, and the grate of the rocking pattern. There are 240 tubes 2 in. in diameter and 12 ft. long. The heating surface is: Fire-box, 126.3 sq. ft.; tubes, 1,497.5 sq. ft.; total, 1,623.8 sq. ft. The grate surface is 25.5 sq. ft. The smoke-stack is 16 in. inside diameter, and the top is 15 ft. above the rail. The boiler is supplied by two Monitor injectors placed right and left. The usual working pressure of steam is 170 lbs.

The six driving-wheels are 64 in. in diameter. The driving-axle journals are $7\frac{1}{2} \times 8\frac{1}{2}$ in. The truck is of the usual pattern, with 30-in. wheels, the truck-axle journals being 5×9 in. The driving-wheel base is 11 ft. 6 in.; the total wheel-base, 21 ft. 7 in. The tires of the forward driver are plain, so that the total rigid wheel-base is only 5 ft. 11 in.

The cylinders are 18 in. in diameter and 24-in. stroke. The piston packing is cast-iron rings, and the Jerome metallic packing is used for the piston-rod and valve-stem. The steam-ports are $16 \times 1\frac{5}{8}$ in. and the exhaust-ports 16×3 in. The valves are the Allen-Richardson balanced valve; they have $\frac{7}{8}$ in. outside lap and $\frac{1}{32}$ inside lap. The greatest travel of the valve is $5\frac{1}{2}$ in., and the lead in full stroke $\frac{1}{16}$ in. The exhaust nozzles are single, $4\frac{1}{2}$, $4\frac{3}{4}$, and 5 in. in diameter.

The tender is carried on two four-wheel trucks of the Schenectady standard pattern, having channel iron bolsters, center-bearings front and back, with additional side-bearings on the back truck. The tender wheels are 33 in. in diameter, and the tender axle bearings $4\frac{1}{2} \times 8$ in. The tender frame is of iron. The tank has a capacity of 3,300 gallons of water, and $5\frac{1}{2}$ tons of coal are carried in the coal-box. The weight of the tender empty is 28,900 lbs.; loaded it is about 66,000 lbs.

The total length of the engine and tender is 54 ft. $5\frac{1}{4}$ in. The total weight of the locomotive in working order is 116,000 lbs., of which 91,000 lbs. are carried on the driving-wheels.

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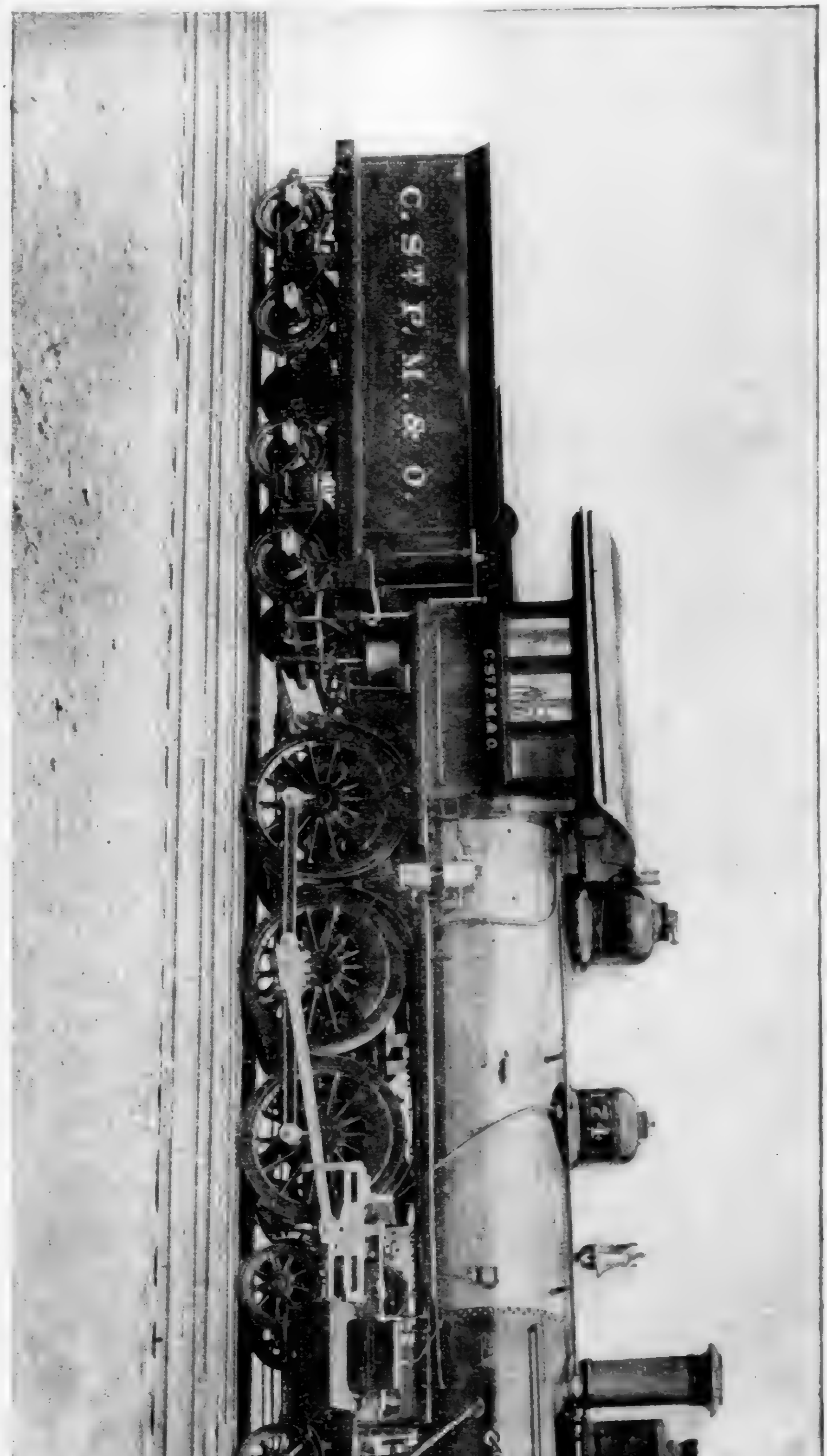

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Avenue, where the passenger station will be built. The tracks on this side will not be brought down to the street level, but the station will be high above the ground, and passengers will be carried up and down in large elevators. On the eastern or Long Island end the approach to the bridge will be an iron or steel viaduct about 9,000 ft. long, and will descend to the present level of the Long Island tracks with a grade of 1 per cent. It is stated the Company is ready to begin work as soon as the necessary authority can be obtained.

THE April report of pig iron production, as given by the *American Manufacturer*, shows that on April 1 there were 280 furnaces in blast, with a total weekly capacity of 188,109 tons—a reduction from March 1 of 10 per cent. in the number of furnaces, and of 3 per cent. in capacity. The reduction was greatest in the anthracite furnaces, although the charcoal and bituminous furnaces also show a falling off. It is not unlikely that the reduction will continue for some time, as the unsold stocks of pig iron are large, and makers do not want to increase them.

Notwithstanding the reduction noted, the manufacture of iron is very much more active than last year. Comparing the statement above with that for April 1, 1891, there is shown an increase of 49, or 21 per cent., in the number of furnaces in blast, and of 74,793 tons, or 66 per cent. in their total weekly capacity.

THE German Canal unions have decided to take part in the International Congress of Inland Navigation, which is to be held in Paris in July next. Much interest is felt in inland navigation in Germany at present, and the representation at Paris will probably be large.

A NEW bridge, which is to be built over the Raritan River and the Delaware & Raritan Canal at New Brunswick, N. J., presents some points of interest. The section over the canal consists of a plate girder span of 62 ft. and a draw-span of 130 ft.; but the river span is to be of masonry, having seven arches, each of 75 ft. span. The masonry will be of brick faced with granite, and the arches will have a rise of 15 ft. only, or one-fifth of the span. The contract for this bridge has been let to Dean & Westbrook, of New York.

COLUMBIAN EXPOSITION NOTES.

IT is stated that Major Meigs, the Engineer in charge of river improvements at Keokuk, Ia., is preparing for exhibition working models of the Government dry docks and engine house, the various boats used in making river improvements and sections of dams, showing the manner of their construction. It is announced that in the Government exhibit will appear a photographic panorama of the Mississippi River from St. Paul to the mouth of the Illinois.

THE Canadian Pacific Railroad Exhibit will include a complete passenger train, and models of its Pacific steamers.

IN the marine section of the Department of Transportation, arrangements have been made to exhibit, among other things, models of the rig of the old frigate *Constitution*; of the *Victory*, the flagship of Nelson; a caravel from Spain, the exact copy of the *Santa Maria*, in which Columbus made his first voyage; canoes of the native traders of the West Indies, hewn from a single tree and propelled by twenty-five paddles. There will be models of such modern racing schooners as the *America*, *Mayflower*, *Puritan* and *Volunteer*. All sorts of stern-wheel passenger and freight steamers for river navigation, steel-screw ferry-boats, electric pinnaces, naphtha launches, etc., will be shown. Then there will appear in their natural order ketches and brigantines, sloops and barks of the Atlantic coast in 1714, rafts, arks, barges, keel-boats and other craft.

SOME BALTIMORE & OHIO HISTORY.

THE table given herewith is a reproduction of a printed sheet of locomotive returns issued by the Baltimore & Ohio Company in 1850—over forty years ago—and the list of engines contained in it is a very interesting one. At that time the road was in operation from Baltimore to Cumberland, 178 miles, and it was nearly completed to Piedmont, 28 miles further. It was not opened to the Ohio River until three years later, in 1853. On this 178 miles, it will be seen that 64 engines were in use, and that they made a total mileage, including the Washington Branch, of 1,215,715 miles, or an average of 18,996 miles each. Some of them show an excellent record for that day, although the mileage is hardly up to the present standard; the greater distance run during the year having been 38,943 miles, which was made in passenger service by the engine *Delaware*, a comparatively new engine. The *Minerva*, an Eastwick & Harrison engine, came next to this with 36,750 miles. The greatest mileage shown by a freight engine was 27,120 miles, which was made by the *Atlas*, also an Eastwick & Harrison engine, which had then been on the road for 11 years, having been built in 1859.

It may be interesting to note that the first four engines on this return—Nos. 1, 2, 3 and 4, which were built by Phineas Davis, at York, Pa., in 1834 and 1835—are still in service at the Mt. Clare shops in Baltimore. These are of the class known as the grasshopper, having an upright boiler and upright cylinders, the motion being transmitted from the driving-wheels through a walking beam. Many of our readers have probably seen one of these engines or an engraving of it. The growth of the road is shown by the fact that for the year ending September 30, 1892, there were 611 engines in service on the Company's lines, and their total mileage for the year was 22,106,204 miles.

The engine No. 1 shown in the list was not the first engine built for the road. The first engine built for regular service—after the trial of Peter Cooper's little experimental machine—was the *York*, which was built by Phineas Davis, and was of the grasshopper pattern. It was shortly followed by two others, which did all the work on the road to July, 1834, when four more were purchased, including the *Arabian*, which is No. 1 on the performance sheet given. The others followed in numerical order.

In this connection it may be of interest to repeat some of the historical facts in relation to the building of the Baltimore & Ohio which have been published before, but may be convenient for reference. The road was opened first for traffic by horse power to Ellicott's Mills, 14 miles from the starting-point in Baltimore, May 24, 1830. It reached Frederick, 61 miles, December 1, 1831; Point of Rocks, 69 miles, April 1, 1832; Harper's Ferry, 81 miles, December 1, 1834; Hancock, 123 miles, June 1, 1842; Cumberland, 178 miles, November 5, 1842; Piedmont, 206 miles, July 21, 1851; Fairmont, 302 miles, January 22, 1852; Wheeling, 379 miles, June 1, 1853.

The Washington Branch was completed to Bladensburg, 32 miles from Baltimore and 24 from the Relay House, July 20, 1834, and to Washington, 40 miles, a month later, on August 25, 1834.

It must be remembered that the Baltimore & Ohio was the most difficult piece of railroad work which had yet been undertaken at the time of its construction. Its location involved the use of grades which many engineers at that time believed to be impracticable, while some of the tunnels and other works on the section crossing the Alleghanies were on a scale exceeding anything yet undertaken. It is not to be wondered at that its progress was comparatively slow.

The Baltimore & Ohio also claims the honor of being the first railroad company incorporated in America, having been organized April 24, 1827, with Philip E. Thomas as President and George Brown as Treasurer. Actual construction work was begun July 4, 1828.

The charter, as presented to the Legislature, was drawn up by Mr. J. V. L. McMahon, and a characteristic anec-

Table G.

Statement of the Number of LOCOMOTIVES on the MAIN STEM and WASHINGTON BRANCH, owned by the Baltimore & Ohio Railroad Company, and exhibiting approximately the Nett Cost of Expenses for Repairs, &c. of the same, for the year ending 30th September, 1850.

MAIN STEM.

Nos. of Engines.	NAMES OF ENGINES.	BUILDER'S NAME	When placed on the Road.		CLASS.	Miles run with Passengers.	Miles run with Tonnage.	Total Number Miles run.	Cost of Repairs of each Engine.	Amount of cost of rebuild'g certain Engines included in repairs.	Average cost of each Engine per mile run.	REMARKS
33	Hercules	Ross Winans	October	1844	1		13,542	13,542	$ 910.77		6.72	
34	Gladiator	" "	November,	1844	1		16,015	16,015	1,736.75		10.84	
35	Buffalo	" "	November,	1844	1		15,622	15,622	1,729.76	420.00	11.07	
36	Baltimore	" "	December,	1844	1		16,008	16,008	1,936 01		12.09	
37	Cumberland	" "	July,	1845	1		16,737	16,737	1,171.24		6.99	
38	Elephant	" "	July,	1845	1		18,573	18,573	1,379.20	275.00	7.42	1st Class—averaged per Mile run 7.04
40	Opequan	" "	July,	1846	1		19,412	19,412	1,262.81		6.50	2d " " " " 5.84
41	Elk	" "	August,	1846	1		17,180	17,180	1,563 36		9 09	3d " " " " 4.86
42	Catoctin	" "	October,	1846	1		15,886	15,886	1,564.06		9.91	4th " " " " 3.79
43	Youghiogheny	" "	November,	1846	1		23,114	23,114	1,463.77		6.34	
45	Tuscarora	" "	December,	1846	1		17,101	17,101	1,389.85		8 12	
46	Allegany	" "	December,	1846	1		11,811	11,811	919 48		7 78	
49	Mount Clare	Balto & Ohio R R. Co	May,	1847	1		9,187	9,187	763.62		8.31	
54	Hero	" " "	May,	1848	1		25,072	25,072	496.89		1.98	
55	Camel	Ross Winans	June,	1848	1		12,621	12,621	1,929.95	704 00	15 29*	
56	Saturn	New Castle Manufact g Co	June,	1848	1		18,672	18,672	1,055 26		5.63	
57	Memnon	" " "	July,	1848	1		25,008	25,008	615 86		2.46	
58	Hector	M. W Baldwin	October,	1848	1		17,987	17,987	1,652.72		9.18	
59	Iris	Ross Winans	December,	1848	1		20,951	20,951	1,570.13		7.49	
60	Cossack	M W. Baldwin	December,	1848	1		13,484	13,484	1,436.09		10.65	
61	Mars	Ross Winans	December.	1848	1		18,464	18,464	1,486 34		8.05	
62	Tartar	M. W. Baldwin	January.	1849	1		10,176	10,176	1,122 03		11.02	
63	Giant	Balto. & Ohio R R. Co	May,	1849	1		24,172	24,172	265.09		1.09	
64	Lion	" " "	March,	1850	1		12,783	12,783	137.39		1.07	
26	Vulcan	Eastwick & Harrison	July,	1840	2		23,188	23,188	543 42		2.34	
44	Baldwin	M W Baldwin	November,	1846	2		15,299	15,299	2,129.99	830.00	13.90	
50	Wisconisco	" "	December,	1847	2		22,046	22,046	1,279.24		5.80	
51	Dragon	" "	January,	1848	2		19,549	19,549	744.23		3.71	
53	Unicorn	" "	February,	1848	2		21,549	21,549	717.77		3.33	
16	Philip E Thomas	William Norris	June,	1838	3		24,357	24,357	269 45		1.10	
17	Mazeppa	Gillingham & Winans	October,	1838	3		13,485	13,485	1,067 90		7.91	
23	Atlas	Eastwick & Harrison	September,	1839	3		27,120	27,120	1,285 88	300.00	4.74	
25	Vesta	William Norris	November,	1839	3		16,904	16,904	596.20		4.13	
27	Jupiter	Eastwick & Harrison	February,	1840	3		22,202	22,202	1,118.24		5.03	
29	Mercury	" "	July,	1842	3	28,789		28,789	2,763 93	1,520.00	9 60	
30	Minerva	" "	February,	1842	3	36,750		36,750	992 09		2.70	
31	Stag	William Norris	May,	1843	3	3,048	19,830	22,878	1,362.34		5 95	
32	Atlanta	Ross Winans	October,	1843	3		25,219	25,219	1,064 56		4.22	
39	Reindeer	" "	December.	1845	3	3,410	19,875	23,285	1,146.34		4.92	
48	Delaware	New Castle Manufact'g Co	January,	1847	3	38,943		38,943	1,201.13		3.08	
52	Juno	Ross Winans	January.	1848	3	4,938	22,971	27,909	719 82		2.56	
1	Arabian	Phineas Davis	July,	1834	4		19,030	19,030	762 31		4 00	
2	George Washington	" "	October,	1834	4		12,628	12,628	585 33		4 63	
3	Thomas Jefferson	" "	June,	1835	4	1,056	14,627	15,683	566 19		3 61	
4	James Madison	" "	June,	1835	4		25,375	25,375	462 42		1.82	
5	James Monroe	" "	June,	1835	4		10,993	10,993	635 09		5 77	
6	John Q. Adams	" "	July,	1835	4		5,259	5,259	625.99		1 19	
7	Andrew Jackson	" "	February,	1836	4		20,511	20,511	469 43		2 28	
8	John Hancock	Gillingham & Winans	April,	1836	4		13,345	13,345	398.26		2 98	
9	Phineas Davis	" "	August,	1836	4		6,303	6,303	309.67		4 91	
10	George Clinton	" "	August,	1836	4		14,892	14,892	655 02		4 39	
11	Martin Van Buren	" "	November,	1836	4		25,217	25,217	621.35		2 46	
12	Benjamin Franklin	" "	April,	1837	4		18,623	18,623	443 22		2 37	
14	William Patterson	" "	June,	1837	4		22,705	22,705	855.36		3 76	
19	William Cook	William Norris	December,	1838	4	22,576		22,576	298.65		1 32	
20	Patapsco	" "	July.	1839	4	6,946	4,152	11,098	512 36		4 61	
21	Monocacy	" "	July,	1839	4		12,683	12,683	613.02		4 85	
22	Potomac	" "	August,	1839	4	3,700	13,105	16,805	1,011 91		6 02	
24	Pegasus	" "	November,	1839	4	16,580		16,580	1,212 32	570.00	7 31	
	59 Engines M. S					166,736	942,620	1,109,356	$59,598 96	$4,619.00		

WASHINGTON BRANCH.

Nos. of Engines.	NAMES OF ENGINES.	BUILDER'S NAME	When placed on the Road.		CLASS.	Miles run with Passengers.	Miles run with Tonnage.	Total Number Miles run.	Cost of Repairs of each Engine.	Amount of cost of rebuild'g certain Engines included in repairs.	Average cost of each Engine per mile run.	REMARKS
15	Isaac McKim	Gillingham & Winans	May,	1838	3		21,702	21,702	834 19		3.84	
28	Arrow	New Castle Manufact'g Co.	February,	1840	3	15,945		15,945	2,081 62	1,067.44	13 05*	*The repairs of the Engine "Arrow" were extraordinary, including a new furnace, enlargement, and a new crank shaft, new truck frame, &c
47	New Castle	" " "	December,	1846	3	27,693		27,693	1,460 73	375 00	5 24	A like remark is due to the Engine "Camel."
13	La Fayette	William Norris	April,	1837	4	24,630		24,630	506 81		2 05	
18	Jos. W. Patterson	" "	October,	1838	4		16,389	16,389	452 97		2 76	
	5 Engines W. B. 59 " M. S. 64 Total.					68,268	38,091	106,359	$5,336.32	$1,442 44		

dote has been preserved in relation to it. After Mr. McMahon had prepared the document, it was read by him to the committee for their adoption. During the reading, as provision after provision was gone over, and the varied and comprehensive powers which the distinguished author had embraced in it were one by one unfolded, the venerable Robert Oliver (one of the first Board of Directors) arose, and in his peculiarly blunt and off-hand manner exclaimed, "Stop, man ; you are asking for more than the Lord's Prayer !" Mr. McMahon smilingly replied "that it was all necessary ; and the more they asked for the more they would get." Mr. Oliver then rejoined, "Right, man ; go on."

This oldest of the trunk lines will, it is understood, have a very interesting historical exhibit at Chicago next year.

It will be of interest to recapitulate here the circumstances attending the building of the first locomotive regularly used on the road. On January 4, 1831, the Baltimore & Ohio Railroad Company issued an advertisement to the inventive genius and mechanical skill of the country, offering most liberal inducements for the production of locomotive steam engines. This being the first proposal

ever issued in the United States for locomotives, will be read with general interest. It was as follows:

OFFICE OF THE BALTIMORE & OHIO RAILROAD COMPANY,
4th January, 1831.

The Baltimore & Ohio Railroad Company being desirous of obtaining a supply of Locomotive Engines of American manufacture, adapted to their road, the President and Directors hereby give public notice, that they will pay the sum of Four Thousand Dollars for the most approved Engine which shall be delivered for trial upon the road on or before the 1st of June, 1831, and that they will also pay Three Thousand Five Hundred Dollars for the Engine which shall be adjudged the next best and be delivered as aforesaid, subject to the following conditions, to wit:

(1) The Engine must burn coke or coal, and must consume its own smoke.

(2) The engine, when in operation, must not exceed three and one-half tons weight, and must, on a level road, be capable of drawing day by day, fifteen tons, inclusive of the weight of the wagons, fifteen miles per hour. The Company to furnish wagons of Winans construction, the friction of which will not exceed five pounds to the ton.

(3) In deciding on the relative advantages of the several engines, the Company will take into consideration their respective weights, power and durability, and, all other things being equal, will adjudge a preference to the engine weighing the least.

(4) The flanges are to run on the inside of the rails. The form of the cone and flanges, and tread of the wheels must be such as are now in use on the road. If the working parts are so connected as to work with the adhesion of all the four wheels, then all the wheels shall be of equal diameter, not to exceed three feet, but if the connection be such as to work with the adhesion of two wheels only, then those two wheels may have a diameter not exceeding four feet, and the other two wheels shall be two and a half feet in diameter, and shall work with Winans' friction wheels, which last will be furnished upon application to the Company. The flanges to be four feet seven and a half inches apart from outside to outside. The wheels to be coupled four feet from center to center in order to suit curves of short radius.

(5) The pressure of the steam not to exceed one hundred pounds to the square inch, and as a less pressure will be preferred, the Company in deciding on the advantages of the several engines will take into consideration their relative degrees of pressure. The Company will be at liberty to put the boiler, fire tube, cylinder, etc., to the tests of a pressure of water not exceeding three times the pressure of the steam intended to be worked, without being answerable for any damage the machine may receive in consequence of such tests.

(6) There must be two safety valves, one of which must be completely out of reach or control of the engineman, and neither of which must be fastened down while the engine is working.

(7) The engine and boiler must be supported on springs and rest on four wheels, and the height from the ground to the top of the chimney must not exceed twelve feet.

(8) There must be a mercurial gauge affixed to the machine with an index rod, showing the steam pressure above fifty pounds per square inch, and constructed to blow out at one hundred and twenty pounds.

(9) The engines which may appear to offer the greatest advantages will be subjected to the performance of thirty days' regular work on the road; at the end of which time, if they have proved durable, and continue to be capable of performing agreeably to their first exhibition, as aforesaid, they will be received and paid for as here stipulated.

P. E. THOMAS,
President.

N. B.—The Railroad Company will provide and will furnish a tender and supply of water and fuel for trial. Persons desirous of examining the road or of obtaining more minute information, are invited to address themselves to the President of the Company. The least radius of curvature of the road is 400 feet. Competitors who arrive with their engines before the first of June, will be allowed to make experiments on the road previous to that day.

The editors of the *National Gazette*, Philadelphia; *Commercial Advertiser*, New York; and Pittsburgh *Statesman*, will copy the above once a week for four weeks and forward their bills to the B. & O. R. R. Co.

During the summer of 1831, in pursuance of this call upon American genius, made by the directors, three locomotive steam engines were placed upon the railroad, only one of which, however, was made to answer any good purpose.

This engine, called the *York*, was built at York, Pa., by Phineas Davis (or rather Davis & Gartner), and after undergoing certain modifications, was found capable of conveying 15 tons at 15 miles per hour, on a level portion of the road. It was employed on that portion of the road between Baltimore and Ellicott's Mills, and generally performed the trip to the Mills in one hour, with four cars—being a gross weight of about 14 tons. This engine was mounted on wheels like those of the common cars, of 30 in. in diameter, and the velocity was obtained by means of gearing with a spur-wheel and pinion on one of the axles of the road wheels. The curvatures were all traveled with great facility by this engine, its greatest velocity for a short time on straight parts of the road having been at the rate of 30 miles per hour, while it frequently attained that of 20 miles, and often traveled in curvatures of 400 ft. radius at the rate of 15 miles per hour. The fuel used in it was anthracite coal, which answered the purpose well; but the engine weighing but 3½ tons was found too light for advantageous use on ascending grades. This engine was of the "grasshopper" type, referred to above, and has been heretofore illustrated.

The performance of this engine fully confirmed the belief of the Board and its Engineer corps, that locomotive engines might be successfully used on a railroad having curves of 400 ft. radius, and from that time forward every encouragement was given by the Company to the inventive genius of the country, to improve on the partially successful experimental engine that had been produced by Mr. Davis.

On April 1, 1832, the first train of cars bearing produce which had descended the Potomac to the Point of Rocks, arrived in Baltimore; the trade from that point continued from that time to increase rapidly, and warehouses, dwellings, and public houses were erected there, and quite a town soon formed. The travel and trade to Frederick, and the increasing business of that portion of the Main Stem between the Monocacy and the Point of Rocks were soon found to constitute no unimportant item in the general receipts of the Company.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXVII.—SAMPLING; AND THE ENFORCEMENT OF SPECIFICATIONS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 163.*)

IN this article we propose to give the method of obtaining the samples from the shipments, and the routine that is followed from the time the specifications are completed up to the paying of the bill for the materials, together with the method of procedure in case of the acceptance or rejection of shipments.

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs; No. XXV, in the February number, on Bearing Metals; No. XXVI., in the April number, on How to Make Specifications.

Let us suppose that the specifications for any material have been prepared which the railroad company desires to use. These specifications are put in print, and quite a stock is prepared. The Purchasing Agents are furnished with a quantity of these specifications, which they send out to the parties who furnish the material, with a note to the effect that on all orders placed with them hereafter materials must be furnished which will conform to these specifications. It will thus be seen that in reality the specifications are a part of the contract as previously stated, and are regarded as binding not only on the manufacturer furnishing the material, but also on the party who buys it.

In the regular routine requisitions for materials come to the Purchasing Agent, and he sends orders to whoever he may decide for any of the materials for which specifications have been prepared. The materials are then delivered by the manufacturers to the nearest station, and in due course of time are transferred to the shop specified on the order.

As soon as the material arrives at the shop, a representative of the Company takes a sample. It will have been observed that in some cases where it seemed necessary to do so, the method of taking the sample has been described in the specifications. In some cases the method of taking the sample is so simple that no special description is necessary. Several points, however, in regard to taking sample are insisted upon absolutely.

First, the sample must always be taken by a repesentative of the Company, and in no case by the manufacturer or any of his representatives.

Second, in the cases of a large number of materials, the shipment is received at the place for which it is designed before the sample is taken. In other cases, however, such as spiral springs, phosphor-bronze, etc., the material may be sampled by the Company's representative at the works before shipment takes place, but in this case the shipment must take place before the Company's representative leaves the works.

Third, in no case shall an average sample be taken, and in most cases only a single sample shall represent the shipment. In some cases, as in the case of phosphor-bronze or mineral wool, two or three samples from different portions of the shipment are taken to represent that shipment.

The following instructions have been issued for the use of the men who do the sampling. The circular applies to both the chemical and physical testing departments, and only that part applying to the chemical testing department is given.

PENNSYLVANIA RAILROAD COMPANY.

PENNSYLVANIA RAILROAD DIVISION.

Motive Power Department.

Circular No. 1.

Instructions for Ordering, Inspecting, and Sampling Materials.

I. Hereafter all requisitions for any of the materials mentioned below must specify the same "As per P. R. R. Co. Specifications." As new specifications are prepared from time to time, instructions in regard to the inspection and sampling of the materials specified will be issued and must be carefully observed.

II. When material has been received, it must be carefully inspected and compared with the bill. If any discrepancies are found, a statement of same, together with the bill, not signed, must be sent at once to the Superintendent of Motive Power for adjustment.

III. The instructions given below must be rigidly observed, and in no case must any portion of a shipment be used until report of test, announcing materials ready for use, has been received, except by special permission from the Superintendent of Motive Power. The report of test must always be attached to bill when this is signed.

IV. The above instructions do not apply to materials received by one shop from another, but only to those received from manufacturers or dealers.

V. The inspection and testing of materials will be done in part by or under the supervision of the party to whom the materials are consigned, and in part by or under the supervision of the Chemist and the Mechanical Engineer, at Altoona.

VI. The following materials must be inspected and sampled, as is described under each heading. The samples must be sent by passenger train to Pennsylvania Railroad Company, care of Charles B. Dudley, Chemist, Altoona, using for this purpose the "sample for test" tags, and filling in the blank spaces as far as possible.

OILS AND TALLOW.

From every shipment of a car load or less of extra lard oil, extra No. 1 lard oil, tallow oil, neatsfoot oil, 150° fire-test burning oil, 300° fire-test burning oil, paraffine oil, well oil, 500° fire-test oil, and of tallow, one sample must be sent, which may be taken from any barrel at random. In sending the sample, it is recommended to use the can and box approved by the General Superintendent of Motive Power, March 7, 1884. These boxes and cans will be returned, for continuous use, to the shops from which they are sent. If in any shipment of a certain kind of oil, any of the barrels are found filled with another kind of oil, or oil of same kind but inferior grade, such barrels must not be used; also, every barrel in each shipment of 150° and 300° fire-test oils must be examined as soon as received, rolling the barrels about before examination. All barrels which are found to contain cloudy oil or oil of inferior color must be set aside. In both these cases samples of either the inferior, the wrong kind, or the cloudy oil must be sent, as above directed, for decision as to what shall be done with it, and a letter written to the Superintendent of Motive Power in regard to the matter.

ZINC.

From every shipment a sample of about half a pound, broken off from any plate or rod at random, must be sent as above directed.

SULPHATE OF COPPER.

From every shipment a sample of about half a pound, taken from any barrel at random, must be sent as above directed. The shipment must also be carefully inspected by a competent person to see that it will all go through a sieve $1\frac{1}{2}$ in. mesh and contain nothing that will go through a sieve of $\frac{3}{16}$ in. mesh. It may be necessary to empty one or more barrels for this purpose. Should the shipment be found not to fill these requirements it must be returned to the shippers.

SAL AMMONIAC.

From every shipment a sample of about half a pound, taken at random, must be sent as above directed.

COMMON SOAP.

Common soap will be bought by weight, and requisitions must be made accordingly. The bars usually weigh 1 lb. From every shipment one bar, taken at random, must be sent as above directed. The tag must state the number of bars in the shipment.

TOILET SOAP.

Toilet soap will be bought by weight, and requisitions must be made accordingly. Cakes of toilet soap usually weigh one quar er of a pound. From every shipment one cake, taken at random, must be sent as above directed. The tag must state the number of cakes in the shipment.

CABIN CAR COLOR.

This material will always be bought dry, and requisitions must be made accordingly. From every shipment a sample of about one quarter of a pound, taken at random from any package, must be sent as above directed.

DISINFECTANT.

This material is made by the laboratory at Altoona, and is furnished either in barrels or in boxes containing two dozen 8-ounce bottles. It is obtained by requisition on Altoona shops, and is ready for use when received.

CAUSTIC SODA.

If this material is received in $\frac{1}{2}$ lb. or 1 lb. boxes, one box taken at random from every shipment must be sent as above directed, and the tag must state the number of boxes in the shipment. If the material is received in barrels or drums, a sample of about half a pound must be sent in a closed tin box as above directed. The gross weight of the shipment must also be verified, and the tag must state the net weight of the shipment.

FREIGHT CAR COLOR.

From every shipment a sample of about a pound must be sent as above directed. Use can and box, same as with oil samples, except that can should have screw top not less than 1¾ in. diameter and can should not be filled more than half full.

MINERAL WOOL.

From every shipment three samples of about half a pound each must be sent as above directed. Each sample must be from a different bag, and must not be compressed during taking or shipment of sample.

PHOSPHOR-BRONZE.

Phosphor-bronze is purchased in lots of 20,000 lbs., or some whole multiple of this number. Requisitions must be made out accordingly. This material is inspected and weighed at point of shipment, and is ready for use when received with report of Inspector and Chemist.

LOCOMOTIVE SPRING STEEL.

From every shipment a sample about three (3) in. long cut off from any bar must be sent as above directed. The sample for test tag must give the size of the bar, as well as the amount in the shipment. If more than one size bar is received in one shipment, a sample of each size must be sent, with a separate tag for each sample.

HELICAL SPRINGS.

These articles are sampled by the Inspector at the works, who at the same time makes the physical test. The shipments are ready for use when received with the reports of the Inspector and Chemist.

DETERGENT.

The shipment must be weighed when received, and a sample of the dry material sent in a box.

WOOD PRESERVATIVE.

From every shipment a sample of about a pint must be sent as above directed. Use the same kind of can and box as with oil samples.

TUSCAN RED.

From every shipment a sample of about a pound must be sent as above directed. Use can and box same as with oil samples, except that can should have screw top not less than 1¾ in. diameter, and can should not be filled more than half full.

Approved.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., June 1, 1887.

The transfer of the sample from the shop or point at which it is taken to the laboratory is done by passenger train. In the case of liquids, a tin can holding about a pint, with a screw top, such as can readily be obtained in the market, is used. These cans are marked with paint on the outside with the name of the material which they are to carry, and also the shop to which they belong. The object of this marking of the cans is so that different materials will not be put in the same can. It causes very serious difficulty if a sample, for example, of 150° burning oil is put into a can which has previously carried well oil, since the color is affected by any remnants of the well oil which might be left in the can, and the color of 150° burning oil is one of the items covered in the specifications. The same thing—namely, contamination of the sample with some of a previous shipment, applies in all cases. Of course cans can be properly cleaned, and cleaning is always made use of, but it is better and avoids much chance for doubt if a can is used only to carry one kind of material. The cans, for the purpose of transportation, are put in small wooden boxes, fitted usually with rope bails. These boxes close with a hasp and staple, and are marked on the top with the following words: "Sample for Test—to be forwarded on Passenger Trains, by Railroad Service. Return to .... Shop." In some cases, in place of the words "Sample for Test" the name of the kind of material for test is put on. This is determined by the shops themselves. When the can is coming to the Laboratory, a tag is tied to the staple, and the train people forward the cans as per the tags, it being understood by all the train service that any boxes or packages marked with tags come as per the tags. These boxes and the sample cans are returned to the shops as soon as we have finished with them. The necessary marking for this purpose is on the top of the box. We of course remove the tag from the staple. The boxes are large enough to hold the sample can, and are made as small and light as possible, so that the train men may handle a good many of them at once. The rope bails facilitate the grasping of a number of them in the hand at one time. If the material is dry, it may be sent in a paper package, having one of the sample for test tags, or in many cases, as for instance, sulphate of copper, sal ammoniac, and other powders, it may be put into one of the little boxes above described. In the case of spring steel and metals, generally a package is made, or special boxes are provided for the purpose, with partitions holding a number of samples, and which have a special bail so that it can be easily handled by the train men. It is not advisable to put metals in a paper package with the tags attached to each sample, since it frequently happens that the rubbing together during transit interferes with the tags.

The "Sample for Test" tag is a matter of some importance, and a copy of the same is given below.

(FRONT OF TAG.)

SAMPLE FOR TEST

From ....

PENNSYLVANIA RAILROAD COMPANY.

Care of

CHARLES B. DUDLEY,

Chemist,

Altoona, Pa.

(BACK OF TAG.)

Amt.......................... *Rec'd*..................

Kind,..

From..

Price,..

Req. No..

It will be observed that on one side are the directions for the shipment, along with the words "Sample for Test," and the shop from which it is sent. On the other side are the amount of material, the date when received, the kind of material, the shipper, the price and the requisition number. All this information should accompany every sample—part of it as a means of identification when the Test Report is sent, and part of it for our records—which information is subsequently used in making out the annual report of the operations of the Laboratory.

The length of time after a shipment arrives at its destination before it can be used varies with different materials. At the more distant shops it takes, perhaps, 24 to 36 hours after the shipment arrives for the sample to be taken, and for this to reach the Laboratory. It takes a varying amount of time, depending on the nature of the material, for the Laboratory to do its work. Many samples are tested and reported the same day as received. This is especially true of oils, the tests of which are capable of rapid application. In some cases, such as phosphor-bronze and some metals, the different tests of which re-

quire either longer time or the number of tests is so great that they cannot be gotten through with in one day, the report passes over to the next day. After the test is finished and the report made, as is described below, it takes a day, or possibly a day and a half, for the report to pass through the offices and reach the shop for which it is designed. It will thus be seen that with many materials there is a chance at the more distant shops of from four to five days intervening between the arrival of the shipment and the receipt of the report of test, ready for use. This delay has never caused very serious difficulty, simply because this time is allowed for in making requisitions for materials. Many of the current supplies are bought by the purchasing agents once a month, and the requisitions are put in in such time as to allow for the necessary delays of placing the order with the manufacturer, for him to fill the order, for the material to be shipped to the place required, and the necessary time for the testing. In certain cases, as above described, the sampling is done at the works. This is especially true of springs and phosphor-bronze shipments; and it is fairly possible that the system of sampling before shipment may be extended quite considerably as time progresses. One of the advantages of this method of sampling is that the time while the material is on the road can be utilized by the Laboratory in making the necessary test, since the sample representing the shipment goes by passenger train, while the shipment is carried at a much slower rate on freight train, and it not infrequently happens with some materials, that the report of test and the shipment arrive at the distant shop at practically the same time.

Some questions may arise as to the advisibility of the three regulations which have been spoken of as being enforced in every case in taking the sample. The reason why we have a Company representative take the sample is entirely obvious. It is not so much that we distrust the parties who furnish the materials, as because we must know from our own knowledge that the sample fairly represents the material, and no fair-minded person would object to this method of procedure. A doubt anywhere in the chain from the taking the sample to the final payment of the bill makes all the rest of the work worthless.

At this point the query may naturally arise, whether, in our experience, there has been discovered any tampering with the men who take the samples or with the inspectors at the works. We will only say upon this point, that during the last seventeen years two or three men who did this work no longer work for the Company. The number of cases of men who have fallen under suspicion, and in which it has been possible to locate the fault on them, has been perhaps as small as could be expected in a large service. It would be too much, of course, to say that false sampling has not taken place, but the system of checks in force on the Pennsylvania Railroad is of such a nature that it would be difficult for any one for any period of time to carry on anything of this kind. One of these checks upon which we rely is this—namely, if inferior material is accepted, owing to the Laboratory having been furnished with a doctored sample, it is almost sure to result that some difficulty will arise in the service, and when this does occur the Laboratory usually hears from it, as it is quite common for all who have had to do with this lot of supplies to say that the material was tested and approved of at the Laboratory. As soon as we hear from it we ask for a portion of the very material which has given difficulty, and then a comparison is made of the sample giving difficulty with the original sample sent us, which gives us a means of checking up the uniformity of the shipment. If the discrepancy seems to warrant such action, we immediately institute an investigation in regard to the sampling.

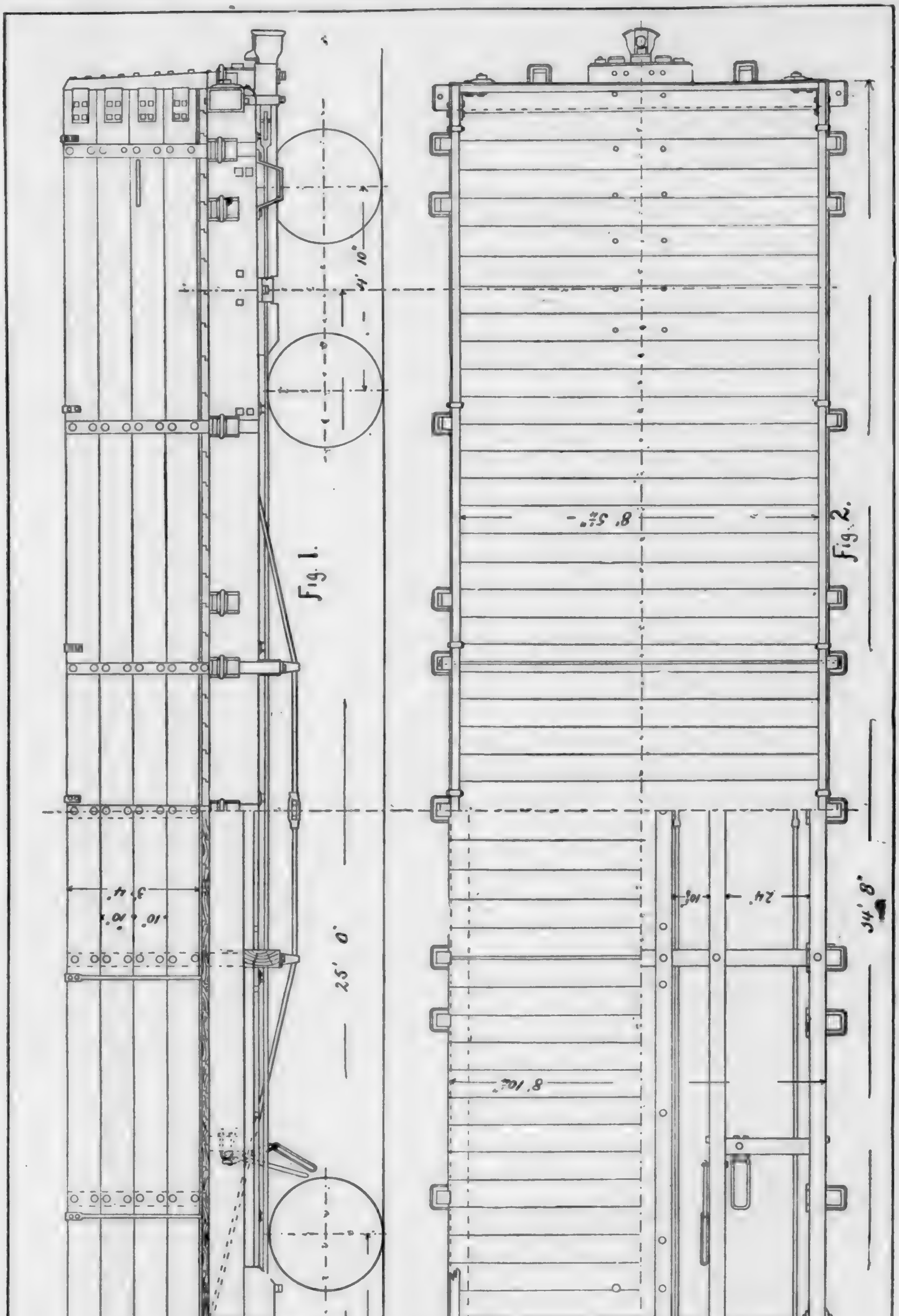
There is another point on which we rely to a certain extent, and that is the honest manufacturers really find it to their advantage to have the specifications honestly enforced, and since the Company usually deals with parties of the best reputation, the temptation to tamper with the men who do the sampling is small. As stated above, we know of only two cases in our experience of nearly seventeen years where the sampling man has not done his work as well as could be expected.

It is quite obvious, we think, why it should be insisted that the shipments should either not be sampled until after they are received at their destination, or should be sampled by the inspector before he leaves the works. It is, of course, clear that unless these points are covered, a dishonest man would have it in his power to send material different from that which was inspected and sampled, and thus, of course, throw uncertainty upon the whole inspection. We prefer, therefore, not to have any doubt arise, and accordingly take all the precautions that can be fairly used. No fair-minded man would, of course, object to this in any sense.

The question of having one sample, or practically a very small amount represent the shipment, has been the subject of some discussion, and some parties have felt that they were wronged by so meagre a sampling. We were led to this by several considerations. First, it is obvious it would be impossible to make an analysis or test of sample from each package, since many materials, such as springs, phosphor-bronze, zinc., etc., do not permit of such sampling, and also in cases where such sampling is possible, as with oils, paints, etc., to analyze a sample from each package would require a small army of chemists. Second, the question of sampling, if we take an average sample, becomes a very serious matter. For example, take a hundred barrels of lard oil. If we have to take a sample from each barrel, it becomes very complicated, and requires skilled or expert persons to do this sampling fairly. The same remark applies to every other material whatever it may be. The labor of sampling becomes very serious if we must sample every package. We accordingly carefully considered the question of the risks involved in taking a single sample. Our reasoning is this. The material ought to be all alike and ought to all fill specifications, for this is what we buy. If it does, then it is immaterial where the sample comes from; if it does not do this, no one is so anxious to find this out as we are. Looked at from this standpoint, the single sample is better than the average sample, because by taking the single sample we stand the chance of striking inferior material. In an average sample the inferior material would be masked by that which was better. We are quite well aware that we stand the chance of getting a sample from the best, and then later finding that the material is not as good as the sample shows; but with our method of sampling, which is fully described in the circular above, we think we are fully as apt to get a sample from the poorest as from the best, and if the manufacturers are willing to take the risk of our getting hold of a poor sample, we are willing to take the risk of getting hold of the best material. We have had in our experience two or three cases in which our method of sampling has detected inferior materials. A single illustration will suffice. An order was placed with a certain firm for 50 barrels of the second grade of lard oil. When the shipment was received and the sample sent to the Laboratory, the sample proved to be the third grade of lard oil, and quite inferior. Accordingly the material was rejected and the whole shipment returned to the manufacturers. Upon receipt of the shipment, they sampled every barrel, and found that 47 of them were of the correct grade, while three of them were of inferior grade. They went to the Purchasing Agent, and claimed that an injustice had been done them, and said that we ought to have taken the 47 barrels. They explained that the three barrels had been added by the Superintendent at the factory, without the knowledge of the firm shipping the material, to fill out the order, as he lacked that number of barrels of the better grade when he wanted to make the shipment. Our reply was that we were in every sense gratified at the turn things had taken; that by their own confession an attempt at fraud had been made, and that they were caught, and the punishment of having to pay the return freight for the annoyance caused us was no more than was justly due them.

We are quite confident that the method of taking a single sample insures us greater uniformity of shipments than if we took average samples, and after now a number of years' experience we have yet to find any manufacturer who seriously objects to the method of sampling which we pursue.

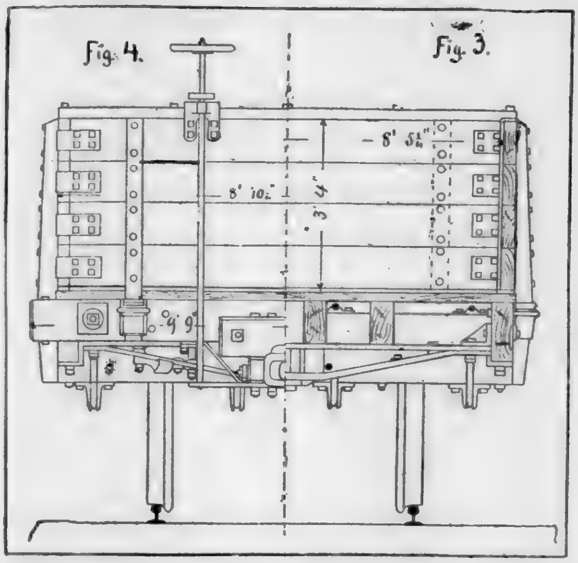
(TO BE CONTINUED.)



STANDARD COAL CAR, 60,000 LBS. CAPACITY, FOR MISSOURI PACIFIC RAILWAY.

MISSOURI PACIFIC STANDARD COAL CAR.

THE accompanying drawings show the standard coal and flat car adopted by the Missouri Pacific Railroad Company. The car is shown with the siding on for coal, and as thus arranged it has a capacity of 60,000 lbs. The general dimensions are: Length of box, 34 ft. 8 in.; length between outside ends of draw-bars, 37 ft. 4 in.; width over

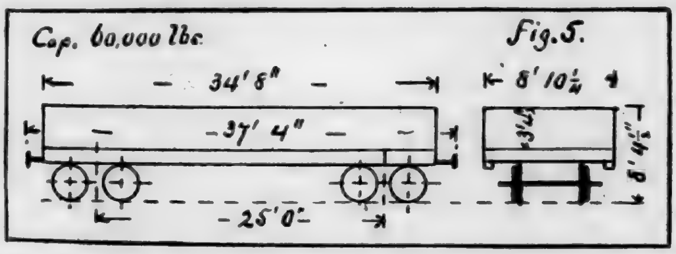


all, 8 ft. 10¼ in.; width inside of box, 8 ft. 5 in.; height from rail to top of box, 8 ft. 1½ in.

The trucks are spaced 25 ft. between centers. They are of the standard adopted for all the freight equipment of the road, and have four 33-in. wheels; the axles are 4 ft. 10 in. between centers.

The drawings show in fig. 1 a side elevation of one-half the length of the car and a section of the other half; in fig. 2 a plan, with the flooring partly removed to show the framing; in fig. 3 a cross-section, and in fig. 4 an end view. Fig. 5 gives the general dimensions.

The trucks will be described and illustrated hereafter. The drawings show so plainly the method of construction of the car body that but little description is required, and it is only necessary to say that the lumber used throughout is of the best quality, while the proportions adopted for the different parts have been given them after careful study of the results of experience. The castings and wrought-



iron work are made as nearly as possible uniform for all the different classes of freight cars on the road.

The design of these cars is due to Mr. Frank Rearden, Superintendent of the Locomotive and Car Department of the road, who had extensive practical experience on the Union Pacific and in charge of several divisions of the Missouri Pacific before his promotion to his present position. The rolling stock of the road is now in better condition than ever before, and its records for the past year show a very low proportion of "bad order" cars.

BRAKE TESTS.

A MEETING of the Committee—Messrs. G. W. Rhodes, E. B. Wall, and George Gibbs—appointed by the Master Car Builders' Association to report at the June annual convention on a standard of efficiency to which all power brakes shall be subjected before they receive the indorsement of the Association, was held at Chicago, March 25, all members being present.

The following specification was prepared and submitted to brake manufacturers and others interested in safety appliances for criticism:

1. Brakes will be tested on either a 50-car train of 34-ft. cars, or on a rack representing the piping of a 50-car train. In the latter case, special effort must be made to have all cocks, screens, angles, and connections identical with those in train service. A drawing will be submitted, showing what shall constitute the proper fittings, pipe, etc., for one car, including engine connections to the pilot.

2. *Pressure.*—Tests will be made with a uniform train-pipe pressure of 70 lbs.

3. *Piston Travel.*—In testing brakes the piston travel must be so adjusted that it will not be less than 6 in. or more than 7 in.

4. *Construction of Triples.*—Triples must be constructed so that they can be secured and operated on apparatus conforming to diagram, fig. 1. (The Committee will publish this diagram at a later date, or will furnish it immediately to any brake company requesting it.)

5. *Application Test No. 1.*—Brakes must commence to apply on the fiftieth car in 3 seconds, or less than 3 seconds, from the moment of first application on the engine, and must indicate at least 55 lbs. in the cylinder in 3½ seconds or less from the initial application.

6. *Application Test No. 2.*—Commencing with the fifth car from the engine, the air from the cylinders of three successive cars will be cut out. The brakes will then be applied as per test No. 5, and if they fail to make the time stipulated on the fiftieth car, the brake will not be considered as coming within the Association's requirements.

7. *Release Test No. 1.*—A uniform pressure of 70 lbs. having been secured in the train-pipe, all the air will be exhausted from the train-pipe. After a pause of 10 seconds, to allow the equalization of the auxiliary and cylinder pressure, the train-pipe will be pumped up to a pressure of 63 lbs., and the record of the condition of the brakes taken. All brakes that are found applied at this pressure will be considered as not releasing.

8. *Release Test No. 2.*—This test will be arranged the same as in No. 7, except in the release. In place of pumping the pressure off, 90 lbs. will be accumulated in the main air reservoir and turned into the train-pipe. After a period of 6 seconds, at which time all brakes should be released, the record will be taken as before.

9. To insure the accuracy of the measurements of time in application and release electrical recording apparatus will be used.

The Committee adjourned, to meet at the Grand Pacific, Chicago, on April 22, 1892, at which time representatives from the various brake companies and others interested were invited to be present and discuss the above tests.

A DISCUSSION OF THE POSSIBILITIES OF THE M. C. B. COUPLER.

BY EDWARD P. EASTWICK, JR., C.E.

(*Concluded from page 169.*)

IN the foregoing exemplification the effect of frictional resistance has been neglected, and it has been assumed that the force acting on the lock, caused by a pulling force, is perpendicular to its bearing surface; but in reality the force on the lock does not act strictly in this manner. Its line of action is in a direction which is the resultant of the perpendicular force and the frictional resistance thereby produced. If ξ is the coefficient of friction, then ξ multiplied by the vertical force on the lock equals the frictional resistance, and the greatest force acting on the lock is the resultant of these two forces.

The force acting on the lock, as also that on the pivotal pin, under these conditions may be either graphically or analytically determined; and as the matter involved is of great practical importance to the economical designing of a coupler, both methods will be given.

Let $A\ B\ C\ D$, in fig. 10, be the parallelogram of forces

as laid off in fig. 7, the force at the locking pin being taken perpendicular to the bearing surface.

From F lay off $F\ I$ equal to $A\ B$ (the perpendicular force), and from I draw $I\ T$ parallel to the bearing face of the lock to represent the frictional resistance (equal to

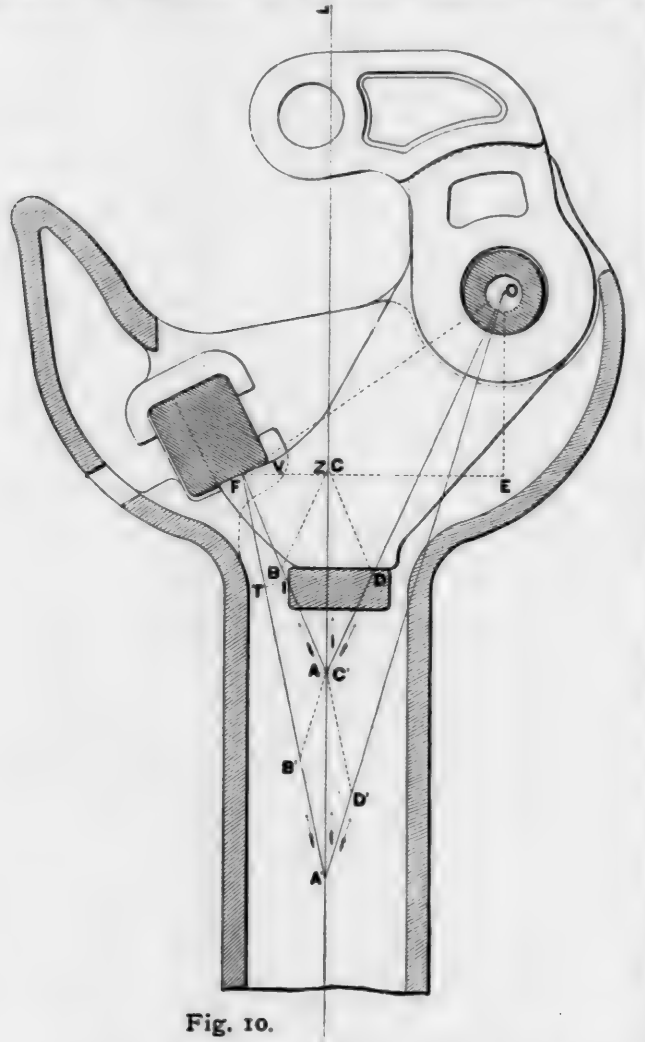


Fig. 10.

$\xi \times A\ B$). Then a line drawn from F through T gives the direction of the resultant, and the intensity of this force may at once be determined by forming the second parallelogram of forces $A\ B\ C\ D$ in the manner as before explained. This constitutes the graphical method.

Analytically the forces acting on the lock and pivotal pin may be determined as follows:

First, neglecting the frictional resistance of the lock, let the angle $V\ F\ E$, which the bearing face of the lock makes with a line drawn from the point F perpendicular to the center line $L\ L$, be given also $F\ Z$, $Z\ E$ and $O\ E$, then

$$F\ O = \sqrt{O\ E^2 + (F\ Z + Z\ E)^2} \text{ and } \operatorname{Sin} O\ F\ E = \frac{O\ E}{O\ F}.$$

In the triangle $O\ F\ A$ the angle

$$O\ F\ A = 90^\circ + V\ F\ O$$
$$V\ F\ O = O\ F\ E - V\ F\ E$$
$$\therefore O\ F\ A = 90^\circ + O\ F\ E - V\ F\ E.$$

From the triangle $F\ A\ Z$ we get

$$F\ A = \frac{F\ Z}{\operatorname{Sin} F\ A\ Z}$$

$$\text{and } F\ A\ Z = F\ A\ C = V\ F\ E.$$

The angle $F\ A\ O$ may now be found. In the triangle $F\ A\ O$

$$(F\ O + F\ A) : (F\ O - F\ A) = \tan \tfrac{1}{2}(F\ A\ O + F\ O\ A) : \tan \tfrac{1}{2}(F\ A\ O - F\ O\ A)$$
$$\tfrac{1}{2}(F\ A\ O + F\ O\ A) = \tfrac{1}{2}(180^\circ - O\ F\ A). \qquad (a)$$

All other quantities entering the equation (a) being known, the value of $\tfrac{1}{2}(F\ A\ O - F\ O\ A)$ is at once determined, and

$$F\ A\ O = \tfrac{1}{2}(F\ A\ O + F\ O\ A) + \tfrac{1}{2}(F\ A\ O - F\ O\ A),$$
and $C\ A\ O = F\ A\ O - F\ A\ Z$.

In the triangle $A\ B\ C$, the angles

$$A\ B\ C = 180^\circ - (B\ A\ C + B\ C\ A)$$
$$B\ C\ A = C\ A\ O, \text{ and } B\ A\ C = F\ A\ C.$$

$$\left.\begin{aligned} A\ B &= \frac{\operatorname{Sin} B\ C\ A}{\operatorname{Sin} A\ B\ C} \times C\ A \\ A\ D &= \frac{\operatorname{Sin} B\ A\ C}{\operatorname{Sin} A\ B\ C} \times C\ A \end{aligned}\right\} \text{I.}$$

I gives the values of the forces acting on the lock and at the pivotal point of knuckle, which result from a pulling

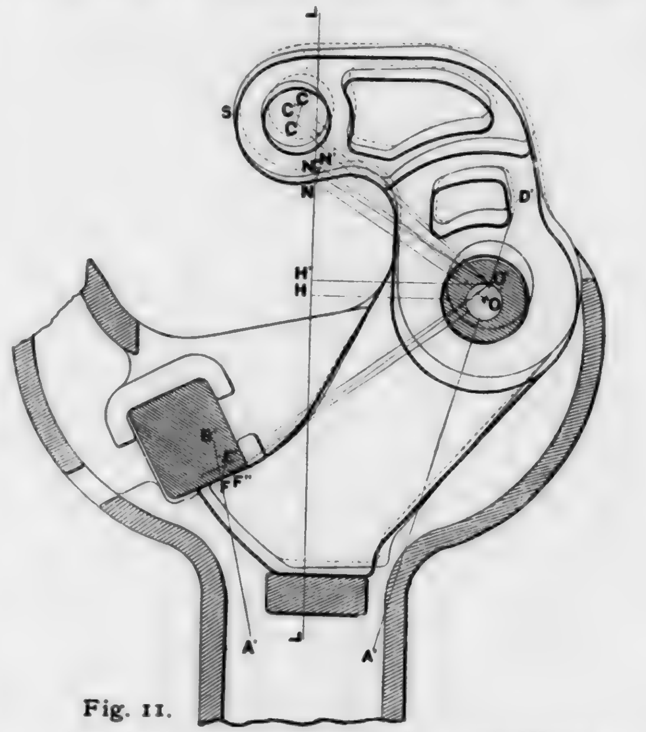


Fig. 11.

force, $A\ C$, when frictional resistance at the bearing surface of lock is neglected.

If, however, the coefficient of friction equals ξ, the frictional resistance at the bearing face of the lock equals ($\xi \times A\ B$), and the resultant force at the lock acts in the direction $A'\ F$ and $\tan A\ F\ A' = \frac{\xi \times A\ B}{A\ B}$, from which the angle $A\ F\ A'$ is determined.

In the triangle $F\ A\ A'$ the angle

$$F\ A\ A' = 180^\circ - F\ A\ C$$
and $F\ A'\ A = 180^\circ - (F\ A\ A' + A\ F\ A') = F\ A'\ Z$.

From the triangle $F\ A'\ Z$ we get

$$F\ A' = \frac{F\ Z}{\operatorname{Sin} F\ A'\ Z}.$$

The angle $F\ A'\ O$ may now be found, for in the triangle $F\ A'\ O$

$$(FA' + FO) : (FA' - FO) = \tan \tfrac{1}{2}(FOA' + FA'O) : \tan \tfrac{1}{2}(FOA' - FA'O) \quad (b)$$
$$\tfrac{1}{2}(FOA' + FA'O) = \tfrac{1}{2}(180^\circ - OFA') = \tfrac{1}{2}(180^\circ - (OFA + AFA').$$

All other quantities entering the equation (b) being known, the value of $\tfrac{1}{2}(F\ O\ A' - F\ A'\ O)$ may be determined, and

$$F\ A'\ O = \tfrac{1}{2}(F\ O\ A' + F\ A'\ O) - \tfrac{1}{2}(F'\ O\ A' - F\ A'\ O)$$
and $C\ A'\ O = F\ A'\ O - F\ A'\ Z$.

In the triangle $A'\ B'\ C'$ the angles

$$A'\ B'\ C' = 180^\circ - (B'\ A'\ C' + B'\ C'\ A')$$
$$B'\ C'\ A' = C'\ A'\ D', \text{ and } B'\ A'\ C' = F\ A'\ Z.$$

$$\left.\begin{aligned} A'\ B' &= \frac{\operatorname{Sin} B'\ C'\ A'}{\operatorname{Sin} A'\ B'\ C'} \times C'\ A'\ * \\ A'\ D' &= \frac{\operatorname{Sin} B'\ A'\ C'}{\operatorname{Sin} A'\ B'\ C'} \times C'\ A' \end{aligned}\right\} \text{II.}$$

* $C\ A = C'\ A'$.

Knowing the proper value of the coefficient of friction, the true value of the intensities of the forces acting at the lock and pivotal point of knuckle caused by any pulling force may be found from II, and these being known, the different parts of the coupler may be properly proportioned to withstand the strains.

The forces resulting from buffing may also, in a similar manner, be analytically determined; but as the demonstration differs little from that given for a pulling force, it will be unnecessary to consider it further.

In conclusion, it may be of interest to investigate more fully the effects of wear in different constructions of the M. C. B. coupler, and to determine more accurately than has heretofore been done results which have been only imperfectly explained. Lost motion developed at the lock and pivotal point of the knuckle is, in its evil effect, in many cases the sole cause of couplers pulling apart after being in use only a very short time; but this is a fault, as already observed, which to a great extent is remediable.

Take, for illustration, the form of coupler shown in figs. 10 and 11, which are more detailed drawings of that given in fig. 7, and let us first determine for this case the effect produced at the coupling face of the knuckle by a wear at the lock or pivotal pin. Formulæ may then be obtained applicable to all designs of couplers.

In fig. 11 draw the line $A' B'$ parallel to $A' B$ in fig. 10, and $A' D'$ parallel to $A' D'$. The wear on the pivotal pin then occurs approximately in the direction of this latter line, and lost motion is taken up in the same direction. This will soon be made clear.

To find the effect of wear at the lock and pivotal pin, it is first necessary to fully comprehend the general results produced by wear at each of the points separately, and afterward the combined effect of the two, in reference to the outward movement of the coupling face of the knuckle, may be easily determined.

To commence with, take the effect of wear at the pivotal pin, and say, for example, the *heavy* full lines in fig. 11 represent the normal or proper position of the knuckle, the center of the pivotal pin being at O. Now let the wear be sufficient to allow the center of revolution of the knuckle to move to the position O' on the line $A' D'$. If then a pulling force is brought to bear at N, and for the moment we suppose the locking pin replaced by a force equal to and acting in the direction of the total resistance offered by the lock, the position of equilibrium for the knuckle is that indicated by the dotted lines.*

The point F will move to F', the point N to N', and the point C to C'. As there has been no wear at the lock, however, the true position for F will be F''; that is, at the intersection of an arc of a circle described from O' and having the radius $O' F'$ (equal to $O F$), with the locking face of the knuckle. This is not strictly true, for it would only be so if the lock were a point. But the lock has a bearing surface, and the shank of the knuckle in the last position would therefore strike first on that point of the surface nearest the center of revolution of the knuckle (the corner of the locking pin in the present case). Consequently the point F'' is drawn in farther than has been assumed. However, as the angle $F' O' F''$ (equal to $O' F O$) is always small for any allowable wear (except in the case where the distance of the lock from the pivotal point is very small, as represented in fig. 6, which is evidently so defective a construction as to be unworthy of consideration), and as the change of position of the point of application of the force on the lock is never very great (so that the bearing surface of the shank of the knuckle in the last position closely corresponds with the normal position), it is at once seen that the assumption made is nearly correct and sufficiently accurate for any practical purpose. The point N, therefore, assumes the position N'' and the point C the position C'' located on the arc described from O' as a center and having the radius $O' N'$ (equal to $O N$), the angle $N' O' N''$ being equal to the angle $F' O' F''$, and the final position of the knuckle resulting from the wear $O O'$ at the pivotal pin is that indicated in fig. 11 by the *light* full lines.

Thus the general effect of wear at the pivotal pin is determined, and the effect of wear at the lock alone has incidentally been shown in the foregoing demonstration. The combined effect of wear at the two points is also apparent, for it is evident that the dotted line in fig. 11 corresponds with the position of the knuckle resulting from the wear $O O'$ at the pivotal pin and a wear at the lock, perpendicular to its bearing surface, equal to $O O' \times \operatorname{Sin} \phi$ ($\phi = F' F F''$).

The amount of outward movement at the coupling face of the knuckle caused by a given wear at either the lock, the pivotal pin, or both, may readily be determined, and the general formulæ applicable to this and all other cases will now be deduced.

If the standard M. C. B. contour lines are used, it will be seen from inspection of them (fig. 12) that it is necessary to determine the position of only one point, for knowing the position of this point, the position of the nose of the knuckle is also known, and on the position of the nose of the knuckle the possibility of two couplers pulling apart is dependent. The point referred to is at C—*i.e.*, the center from which the arc is described, which forms the contour of the nose of the knuckle, and its position should be known in reference to the line $A B$ (or one parallel at a known distance) and the center line $L L$. The distance which the point is from the line $A B$ determines the amount of the outward movement of the coupling face of the knuckle, and thus the lateral movement of which the coupler is capable. The distance from the line $L L$ determines the amount of lateral movement required before the knuckles of two locked couplers can pass one another.

The lateral movement of the couplers increases with the distance of the point C (hence the coupling face of the knuckle) from the line $A B$, and the amount of lateral movement necessary for the knuckles to pass increases with the distance of the point C from the center line. *Hence it is desirable, in coupler construction, that the effect of wear on the lock and pivotal pin shall result in the least outward movement of the point C with relation to A B, and the greatest outward movement with relation to L L.*

Referring to fig. 11, let the wear on the pivotal pin in the direction $A' O$ be represented by $O O'$ (equal to κ), and to avoid confusion by too many lines, let the demonstration now be transferred to fig. 13, in which similar letters indicate similar points and lines in both figures. The directions of the lines have been slightly altered so as to make the latter figure more clear. Thus in fig. 13 F is the point of application of the force at the lock when no wear has taken place, or, in other words, when the knuckle is in its normal position. F' is the position of the same point, when, as before, a force equivalent to the resistance offered by the lock is substituted for the lock, and F'' is the final or true position of the same point resulting from a wear, $O O'$, at the pivotal pin alone. O and O' are taken the same as in fig. 11, and C, C' and C'' are the several positions of the corresponding point in the same figure. N, N' and N'' and the lines $N O$, $N O'$ and $N O''$ are omitted.

Draw the dotted lines $H O$ and $V O'$ both perpendicular to $L L$, and $C H$, $C' H'$ and $C'' H''$ parallel to the same line. Also extend the bearing face of the lock $F X'$, and draw the dotted lines $O X$ and $O' X'$ perpendicular to it.

Given the following dimensions:

$$F X = L \qquad O H = H$$
$$O X = T \qquad C H = P$$
$$\text{and angle } F'' F Y = \beta.$$

The angle $F' F F''$ has been calculated. $R = \sqrt{L^2 + T^2}$, and $r = \sqrt{H^2 + P^2}$.

* It will readily be understood that if the center of revolution of the knuckle is always on the line $A' D'$, the force acting on the lock (which is considered to act at the center point of the bearing surface) will vary both in direction and intensity for every change of position of the point of revolution of the knuckle. But as it has previously been shown that the lock is only capable of resisting a force in a direction which is the resultant of the normal force and frictional resistance, the assumption that the force at the pivotal pin always acts in the direction of the line $A' D'$ is not strictly correct. In fact, the direction of the force is constantly changing, and the wear at the pin and path of the center of revolution would be a curve tangent to the line $A' D'$ at O. However, as this is not intended to be an *exact* mathematical determination, and as the angle which the line $A' D'$ makes with $L L$ is always small in properly constructed couplers, it will be admissible and sufficiently accurate for all practicable purposes to consider $A' D'$ as the direction of movement of O up to the allowable wear on the knuckle or pivotal pin.

$$\text{Sin } O\,F\,X = \frac{T}{R} \text{ and } \cos O\,F\,X = \frac{L}{R}.$$

$$\text{Sin } O'\,F''\,X' = \frac{T + \kappa \sin\phi}{R} \text{ and}$$

$$\text{Cos } O'\,F''\,X' = \frac{\sqrt{R^2 - (T + \kappa \sin\phi)^2}}{R}.$$

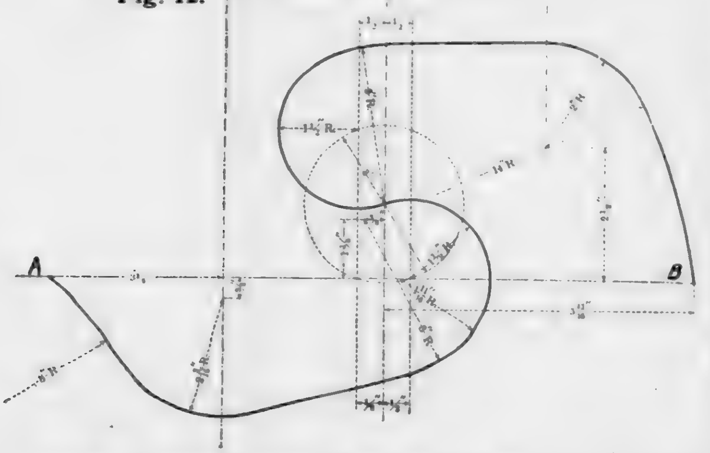
The angle $F'\,O'\,F'' = O'\,F''\,X - O\,F\,X$, and if this angle is represented by a, it follows from the general formulæ for the sine and cosine of the difference of two angles:

$$\left.\begin{aligned} \text{Sin } a &= \frac{(T + \kappa\sin\phi)\,L}{R^2} - \frac{\sqrt{R^2 - (T + \kappa\sin\phi)^2}\,T}{R^2} \\ \text{Cos } a &= \frac{\sqrt{R^2 - (T + \kappa\sin\phi)^2}\,L}{R^2} + \frac{(T + \kappa\sin\phi)\,T}{R^2} \\ {}^*\kappa &= \frac{\sqrt{R^2 - (L\cos a - T\sin a)^2} - T}{\text{Sin }\phi}. \end{aligned}\right\} \text{III.}$$

From III. the value of a may be calculated for any wear κ at the pivotal pin, and since the angle $F'\,O'\,F''$ equals the angle $C'\,O\,C''$ (as may be seen by inspection of fig. 13), the value of a thus found determines the position of *C for wear at the pivotal pin alone*.

Formulæ III. are general, and applicable to all cases, but it must be remembered that the angle ϕ is always measured

Fig. 12.



from the normal position of the bearing face of the lock in a direction contrary to the hands of a clock, and that the angle a is measured in the same direction from the line $O\,F$ in its position $O'\,F'$.

If in III. a vertical wear at the lock equal to $-\kappa_{,}$ is substituted for $\kappa\sin\phi$ —

$$\left.\begin{aligned} \text{Sin } a_{,} &= \frac{(T - \kappa_{,})\,L}{R^2} - \frac{\sqrt{R^2 - (T - \kappa_{,})^2}\,T}{R^2} \\ \text{Cos } a_{,} &= \frac{\sqrt{R^2 - (T - \kappa_{,})^2}\,L}{R^2} + \frac{(T - \kappa_{,})\,T}{R^2} \end{aligned}\right\} \text{IV.}$$

from which the position of the point C may be determined for wear at the lock alone.

If there is a wear equal to κ at the pivotal pin and a perpendicular wear equal to $\kappa_{,}$ at the lock, the point F will take a position, F''', on the arc described from O' as a center between F' and F'' (F''' is not shown in figure), and if the angle $F'''\,O'\,F$ is represented by $a_{,,}$, then

$$\left.\begin{aligned} \text{Sin } a_{,,} &= \frac{(T - \kappa_{,} + \kappa\sin\phi)}{R^2}\,L - \frac{\sqrt{R^2 - (T - \kappa_{,} + \kappa\sin\phi)^2}}{R^2}\,T, \\ \text{Cos } a_{,,} &= \frac{\sqrt{R^2\,(T - \kappa_{,} + \kappa\sin\phi)^2}}{R^2}\,L + \frac{(T - \kappa_{,} + \kappa\sin\phi)}{R^2}\,T, \end{aligned}\right\} \text{V.}$$

$$^* \text{Sin } F''\,O'\,X' = \cos O'\,F''\,X' = \frac{\sqrt{R^2 - (T + \kappa\sin\phi)^2}}{R}$$

$$\text{Sin } F''\,O'\,X' = \sin(F\,O\,X - a) = \frac{L}{R}\cos a - \frac{T}{R}\sin a.$$

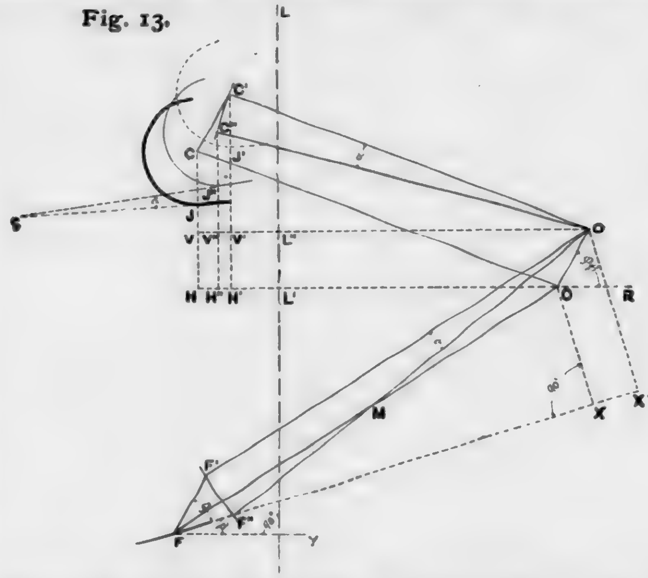
Equating and solving for κ, we get:

$$\kappa = \frac{\sqrt{R^2 - (L\cos a - P\sin a)^2} - T.}{\text{Sin }\phi}$$

The position of the point C is, as before explained, located with reference to the center line $L\,L$ and the line $H\,O$ at a known distance, d, and parallel to $A\,B$ (fig. 12).

Let H' and P be the vertical distances of the point C from $L\,L$ and $H\,O$, respectively, when the knuckle is in its normal position, and let x and y represent similar distances

Fig. 13.



of the point C when the knuckle has assumed the position caused by a wear, κ, at the pivotal pin, or a perpendicular wear, $\kappa_{,}$ at the lock, or both. The angle $C'\,O\,V$ equals the angle $C\,O\,H$ from construction.

Now if in fig. 13 the angle $C'\,O'\,C''$ is made equal to $a_{,,}$ so that C'' is the position of C resulting from wear κ at the pivotal pin, and a perpendicular wear, $\kappa_{,}$ at the lock, we obtain:

$$\begin{aligned} C''\,V'' &= r\sin(C'\,O'\,V' - a_{,,}) = P\cos a_{,,} - H\sin a_{,,} \\ V''\,O' &= r\cos(C'\,O'\,V' - a_{,,}) = H\cos a_{,,} + P\sin a_{,,} \end{aligned}$$

and

$$\left.\begin{aligned} y &= P\cos a_{,,} - H\sin a_{,,} + \kappa\sin(\phi + \beta) \\ x &= H\cos a_{,,} + P\sin a_{,,} + H' - H - \kappa\cos(\phi + \beta) \end{aligned}\right\} \text{VI.}$$

VI. gives the position of C relative to the lines $H\,O$ and $L\,L$, for a wear of κ and $\kappa_{,}$ at the pivotal pin and lock, respectively, $a_{,,}$ being calculated by V.

If in V. κ equals zero and consequently $a_{,,}$ equals $a_{,}$ (vide IV.) the formulæ become:

$$\left.\begin{aligned} y_{,} &= P\cos a_{,} - H\sin a_{,} \\ x_{,} &= H\cos a_{,} + P\sin a_{,} + H' - H, \end{aligned}\right\} \text{VII.}$$

which gives the position of C for a wear of $\kappa_{,}$ *at the lock alone*.

If in V. $\kappa_{,}$ equals zero and consequently $a_{,,}$ equals a (vide III.) the formulas become:

$$\left.\begin{aligned} y_{,,} &= P\cos a - H\sin a + \kappa\sin(\phi + \beta) \\ x_{,,} &= H\cos a + P\sin a + H' - H - \kappa\cos(\phi + \beta), \end{aligned}\right\} \text{VIII.}$$

which gives the position of C for a wear of κ *at the pivotal pin alone*.

It will be seen from III. that the angle a decreases with the angle ϕ, and that when this latter becomes zero a also becomes zero, and from VIII.

$$\begin{aligned} y_{,,,} &= P + \kappa\sin\beta \\ x_{,,,} &= H' - \kappa\cos\beta. \end{aligned}$$

This case is represented in fig. 4.

If the angle ϕ becomes minus, a is also minus, and

$$\begin{aligned} y_{\text{IV}} &= P\cos(-a) - H\sin(-a) + \kappa\sin(-\phi + \beta) \\ &= P\cos a + H\sin a + \kappa\sin(\beta - \phi), \end{aligned}$$

and

$$x_{\text{IV}} = H\cos a - P\sin a + H' - H'' - \kappa\sin(\beta - \phi),$$

which shows that the point C is caused to move out a greater distance and approach the line $L\,L$ for the same wear at the pivotal pin. This case is represented in fig. 1.

Again, the value of a increases with the angle ϕ, and y

becomes a minimum when ϕ equals $+ 90°$; a also increases as R decreases, and hence the minimum value for y and maximum value for x for wear at the *pivotal* pin alone occur when

$$\phi = + 90°$$
$$\text{and } R = \text{minimum.}$$

But the minimum value for y and maximum value for x for wear at the *lock* alone occur when the bearing face of the lock corresponds with a radial line from the center of revolution and when R is a maximum.

Therefore, bearing in mind that the wear at the lock and pivotal pin is proportional to the forces acting at these points, it would seem that the most advantageous construction of the M. C. B. coupler would be reached when the angle ϕ were made equal to $+ 90°$, while at the same time the direction of the bearing face of the lock corresponded with the radial line from the center of revolution, and R and r had such relative values that the total strain on the lock and pivotal pin was equalized and a minimum.

AN IRON AND OAK PAVEMENT.

(Extract from paper read before the American Society of Mechanical Engineers, by J. Wendell Cole, of Columbus, O.)

THE desideratum for the best pavement appears to be one which would give a good and safe foothold to the horse, which would afford a good surface for traffic, and which would be durable. One which could combine lack of noise with these other advantages would appear to be well in the front rank for meeting the requirements of today.

There is a small piece of pavement 9 ft. $\times$ 27 ft. 4 in, in Columbus, O., at a place where the traffic is very heavy

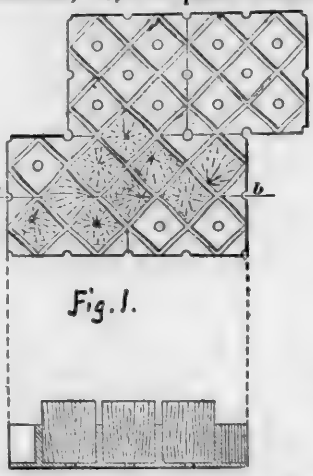


Fig. 1.

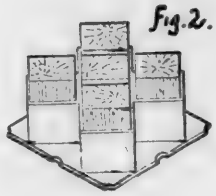


Fig. 2.

—a crossing over the sidewalk from the principal business street into the freight yards of the "Big Four Line," which has attracted considerable attention. It is a combination pavement of cast-iron pockets and bottom plate with oak blocks, making an even bottom surface and thus avoiding settling into holes. These iron pockets are filled with green oak blocks $3\frac{7}{16}$ in. square on the top and about 5 in. long. These blocks are driven into the iron pockets some 3 in., and receive the traffic on the end of the grain of the wood. Each full-sized bottom plate has 5 pockets, 4 half pockets and 4 quarter pockets. See detail drawings, figs. 1 and 2. Thus at the joints of the bottom plates in some instances, 2, 3, or even 4 bottom plates may support one of the hard-wood blocks, dividing the strain and holding an even surface on the upper side of pavement. Each iron pocket has a small hole for draining away any moisture. This surface stands the wear evenly, and the kind of traffic using it is heavy loaded wagons.

This block pavement was put down May 30, 1890, with the newly sawed oak blocks projecting 2 in. In August, 1890, I inspected it, and found them hammered and worn to $1\frac{7}{8}$ in. projection; and in September, 1891, another inspection showed them projecting about $1\frac{3}{4}$ in. above the metal pockets. The traffic crossing it includes largely loads of roofing slate and of rough curb-stones, in addition to the general commercial traffic of the "Big Four Line," and loads of from 3 to 5 tons each are quite frequent. The railroad yard surface is broken-rock macadam. The street is asphalt. I am informed that at this crossing new road metal has been deposited in the yard within 90 days, while the asphalt was renewed for some space from this block pavement about four months ago.

It appears that this pavement so far meets the requirements of

1. A substantial roadway to stand heavy traffic.
2. A good firm foothold for the horse.
3. A practically noiseless roadway suited to heavy traffic, but also comfortable for pleasure driving or a wheelman.

ELECTRICAL TRANSMISSION OF POWER.

(Abstract of paper by A. Saunders Morris; from the *Proceedings* of the Engineers' Club of Philadelphia.)

IF the calculations based by Herr Beringer on experiments made of the efficiency of hydraulic, pneumatic and wire-rope transmissions of power be accepted and compared with experiments on electric transmission, we find that power in large units can be transmitted by electricity more economically than by any of the other methods named for distances of $2\frac{1}{4}$ miles or over. Wire rope is the only system which leads it for shorter distances. These electrical efficiencies are based on 90 per cent. efficiency of generator and motor respectively and a varying efficiency of line. The proper efficiency of the line, or, in other words, the energy lost between the generator and the motor, will depend upon the cost of the power, and interest and depreciation on the capital outlay. If the production of power is expensive it will, of course, be better economy to put more material in the line and lose less energy in the transmission. If we assume that 100 H.P. is available at the generator pulley, and that the efficiency of the generator and motor is 90 per cent. each, the horsepower delivered by the motor shaft will be 64.8 if the line efficiency is 80 per cent., and 72.9 if the line efficiency is 90 per cent. In the former case we will lose 18 H.P. in heating the copper line wire, while in the latter case but half that amount. The amount of copper in the line will be doubled in the latter case, but the cost of construction will be about the same. If we assume the cost of the motor to be proportional to the horse power, it will be increased about 10 per cent. We must therefore balance the additional cost of the line and motor against the value of the 10 per cent. additional power obtained at the motor pulley.

A few figures on the cost of transmission plants erected abroad by the Oerlikon Works may be of interest.

Distance in Miles.	Horse-Power Delivered.	Generators.	Motors.	Line.	Total.*	Per H. P. Delivered.
1 87	85	$3,135	$2,741	2,155	$9,220	$108.50
0.56	71	2,155	1,960	294	5,100	71.60
1.56	150	3,720	3,525	1,615	10,020	67.20
6.25	11	647	540	2,350	4,700	42.60
2.20	51	1,761	1,567	1,469	5,595	109.40
5.00	41	1,174	980	1,682	5,000	121.10
3.75	220	5,190	4,700	3,135	14,500	66.20
0.43	510	.....	.....	.....	33,250	65.30

The last plant on the list is at Schaffhausen, and consists of two generators of 300 H.P. each, one twin motor of 390 H.P., and two small motors of 60 H.P. each. The line consists of four stranded conductors having an area of .437 sq. in. each, and is supported at four points, exclusive of the termini. The manufacturers have guaranteed a commercial efficiency at ordinary full load of 78 per cent.; also that the machines must be capable of transmitting an excess of 20 per cent. over the normal power for one hour and a half without damage. The wear of one set of

* This includes regulating apparatus, poles, insulators, lightning arresters, erection and supervision.

brushes to be not less than 2,000 hours, and the life of a commutator not less than 2,000 hours. The variation of speed of the motors between running idle and under full load not to exceed 3 per cent.

In all of the previously mentioned plants direct or continuous current has been employed, but the difficulty of commutating currents of high potential has prevented the installation of many plants where the distances were so great that low potentials and heavy currents were financially impossible. This has led engineers to turn to the alternating current, not only on account of the ease with which it can be transformed from large quantity and low potential to small quantity and high potential and inversely, but also on account of the absence of commutators on either motor or generator. In avoiding the difficulties of commutation, engineers have been confronted by another—namely, the absence of an efficient alternating motor which would start itself. Any alternating current dynamo will run as a motor if it is brought up to speed in the first place; and further, unless very much overloaded, will maintain the same speed as the generator as absolutely as if it were mechanically coupled.

Another system of alternating current transmission has been devised, which overcomes the starting difficulty by the use of two or more currents differing in phase. This requires two or more wires, which are, however, in many cases unobjectionable. This is the type of generator and motor built by the Oerlikon Engineering Works for the Lauffen-Frankfort transmission plant.

In this country the number of transmission plants is comparatively small, and reliable information as to cost and efficiency is very difficult to obtain.

The Brush Electric Company has installed at the Dalmatia Mine in California a compound-wound generator, giving 40 amperes and 1,800 volts, which is driven by a Pelton water-wheel under a head of about 100 ft. The current is carried to the motor at the mine, 1½ miles distant, the power being used for driving stamps and other mining machinery.

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Another plant which is being installed by the same company is at the Calumet & Hecla mines. This plant consists of compound-wound generators, five in number, each capable of furnishing a current of 80 amperes at 970 volts, which is carried partly by an overhead line and partly by armored cable dropped through a bore-hole, a distance of about 8,000 ft., to the motors, also five in number, which drive the pumps. The speed of the generator is 850 and of the motors 920 revolutions per minute. The horse power delivered by each motor is something over 80, and the efficiencies of the generators, motors and line being each about 90 per cent., we have a commercial efficiency of almost 73 per cent. This plant is to be run in competition with a pneumatic system.

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Probably the only long-distance transmission plant in this country in which alternating current is used was installed almost a year ago by the Westinghouse Electric & Manufacturing Company at Telluride, Col. The generator is capable of delivering about 30 amperes and 3,000 volts. The line is No. 3 B. & S. insulated wire, carried up the mountain on poles to the mine, a distance of 2.75 miles. This is a synchronous system—that is, as explained before, the motor and generator, being similar machines, run at exactly the same speed, irrespective of the amount of work done. The motor must therefore be brought up to speed by some auxiliary device before the current is thrown on. In this case the starting device is a small two-phase motor. Its efficiency is not important, as it has only to run for about three minutes, when the current is switched from it to the synchronous motor, and the load thrown on. There are some very simple devices for automatically breaking the circuit, if the motor should drop out of step from excessive load; and as there is no commutator to look after, or regulation to be done, the plant requires very little attention. The cost of this plant, exclusive of erection and pole line, is said to have been $10,000, or about $100 per H.P., and its commercial efficiency about 75 per cent.

The best electromotive force to be used must, to a certain extent, be decided for each case, the decision being governed by surrounding conditions, such as cost of power, distance of transmission, and the like.

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With alternating currents, however, the voltage may be carried to 5,000 volts, and even higher if raising and lowering convertors are used, so that the potential on moving machinery may be kept down to a moderate figure. Alternating current motors do not in general require a commutator subjected to the high voltage used on the line, but, instead, have two or more solid rings or collectors, by which means sparking is entirely avoided.

The efficiency of direct and alternating current motors and generators is about the same, and may be taken at 90 per cent. as an average figure. The efficiency of the line will vary in practice from 75 to 95 per cent., which will give a plant efficiency, reckoned from the generator pulley to the motor pulley, of 61 to 77 per cent. One of the advantages of electrical transmission is that the plant efficiency remains almost constant for wide variations of load, for, as the motor and generator efficiencies decrease, the line efficiency increases.

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(*Continued from page 176.*)

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vancing screw would constantly have fresh particles of air to work upon, and there would be a reduction in the slip which necessarily must occur when its thrust is measured in a fixed position.

The next experiment was tried with the Government Dock Yard launch, which was 31 ft. long and 8 ft. beam. Its ordinary water screw was removed, and an air propeller of canvas was substituted, which was 20 ft. in diameter and had a total area of 250 sq. ft. This area was found much too large, but by reducing it to about 150 sq. ft. an average speed of nearly 7 knots was attained by the launch, whose speed with the ordinary water screw and the same power (11.3 indicated horse power) was a maximum of 7.3 knots per hour. There was, however, a slip of the driving rope which was estimated as wasting about 2 horse power, and the director estimated that the speed with the air propeller would have been 7.5 knots per hour if the gear had worked properly. As on previous trials, 75 per cent. of the winds increased the thrust of the propeller.

The apparatus for the next experiment, which was tried in 1887, was made by Messrs. *Dahlstrom & Lohman*, engineers, of Copenhagen. An air propeller with three vanes of thin sheet steel, and an area of about 5 sq. ft., was fitted to a boat 16 ft. long and 4½ ft. beam, and rotated by man power. It is stated to have produced a thrust of 10 lbs., with an effort of about 100 foot-pounds, or at the astonishing rate of 55 lbs. per horse power; but it must have been assisted by wind blowing athwart the blades, for Mr. *H. C. Vogt*, in a letter published in London *Engineering* for December 4, 1891, says, in discussing Aerodynamics, that "with 1 indicated horse power it is not possible to obtain a thrust of over 40 lbs. to 45 lbs. with an air propeller—say 50 lbs. to 60 lbs. per brake horse power on the shaft—just the same in whatever manner area, pitch, and revolutions are varied."

On the basis of these Copenhagen experiments Mr. *John P. Holland*, in a very interesting letter, published in the New York *Herald* in November, 1890, claims that it is even now possible to navigate the air upon the screw principle, by simply combining things already tried and proved by various experimenters; and he gives the elements of a proposed steam apparatus, weighing some 7,000 lbs., and capable of carrying two men, with supplies of fuel, etc., sufficient to sail from 8.44 to 23.6 hours. Details of the design and method of operation are withheld until a patent can be secured. As has already been said in referring to Mr. *Maxim*, it is probable that such a machine can be made to rise upon the air; but special appliances will be required to secure safety in case the machinery breaks down while under way, and in effecting a landing.

A somewhat similar proposal is made in a pamphlet published in 1891 by Mr. *James Means*, of Boston, but he gives only a scanty glimpse of the arrangement by which he thinks the problem could be solved. He proposes one screw on a vertical shaft, sustaining a car with a pair of widely extended vertical planes, to prevent rotation of the apparatus, and concludes by saying: "If you want to bore through the air, the best way is to set up your borer and bore."

Our knowledge of the action of aerial screws is almost wholly experimental; and it would seem, in the present chaotic state of theory as applied to the screw, as if this remark of Mr. *Means* was almost as comprehensive and reliable as anything on the subject of aerial screws which has been published up to the present time. The writer feels quite certain that it contains in a condensed form as much reliable detailed solid information as several mathematical articles of considerable complexity which he has consulted, and it will be seen, by closely analyzing Mr. *Means's* suggestion, that after its entire adoption in the spirit in which it is made, there would be little left to be desired in the development of aerial screws.

Among the inventors who have most deeply and most intelligently studied the action of screws must be mentioned M. *G. Trouvé*, of Paris, whose artificial flapping bird has already been noticed under the head of "Wings." He has proceeded almost wholly in the experimental way, and he has accomplished some very remarkable results. He began his experiments with marine screws applied to electric launches about 1881, and soon developed an electric motor weighing but 33 lbs. per horse power (primary battery not included), which rotated an improved marine screw some 2,400 turns per minute.*

In 1886 he exhibited to the French Academy of Sciences a new method of constructing geometrically accurate screws by a process so simple that any workman can carry it out, and that the cost is very much reduced. He has also experimented, ever since 1867, with aerial screws, and has reached the conclusion that for the latter the best results are obtained when the pitch is equal to the diameter, or a little less,† contrary to marine practice, where pitch is generally 1.3 times the diameter.

In 1887, at the Scientific Congress at Toulouse, and in 1888, before the French Société de Physique, M. *Trouvé* exhibited the electric motor and aerial screw represented in fig. 35. The motor is the lightest ever built, weighing but 3.17 oz., and developing 868 foot-pounds per minute, or at the astonishing rate of 1 horse power for each 7.42

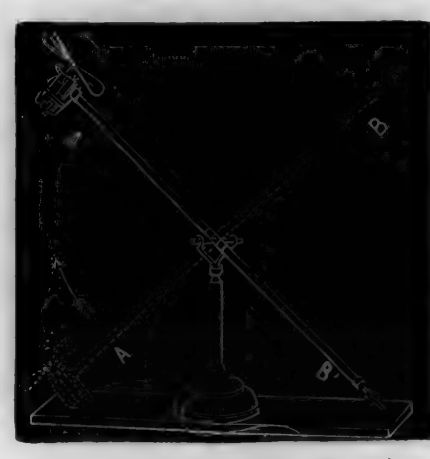


FIG 35.—TROUVE—1886.

lbs. weight. It is wholly of aluminum, except the magnetic circuit, which is necessarily of very soft iron; and the armature is directly connected with a very light aerial screw, geometrically perfect, which was constructed by the process communicated to the French Academy of Sciences.

This apparatus, upon being placed in one pan of a pair of scales, and connected with a source of electricity of 40 Watts constant delivery, lightened itself of its entire weight by action upon the air. To make the experiment more striking, M. *Trouvé* then arranged it at the extremity of a balanced beam, as shown in the figure, connecting it with the electric supply through the standard, the knife edges and the beam. Then upon turning on the current, the screw began to revolve, and the balanced beam rose from the position $A\ B$ into the position $A'\ B'$, with the expenditure of 868 foot-pounds per minute, which M. *Trouvé* says is capable of raising it at the rate of 72 ft. per second.

Inasmuch as he estimates that this minute motor has only an efficiency of 20 per cent., and that a similar one of 50 to 100 horse power would possess an efficiency of 80 to 92 per cent., it would seem that M. *Trouvé* now has it in his power to go up into the air with a pair of aerial screws, rotating in contrary directions in order to insure stability, moved by his wonderfully light motor, to float, to hover, and to move about at pleasure so long as he remains within the limits of length, of strength and of weight of a connecting wire to convey the electric force from a dynamo and steam engine, which remain on the ground, to the electric motor and aerial screw in the air.

This, as he points out, would be of practical use on the battle-field or in a besieged city, to observe the enemy; and it is not impossible that he will exhibit such an apparatus at some International Exposition; but he believes that he has now designed a still better solution of the problem; and we shall see, when we come to treat of aeroplanes, that he made the plans for an apparatus of that kind which seems to him to solve, both in arrangement

* Histoire d'un Inventeur—Barral. Page 416. † *Ibid* Page 442.

and motive power, the all-important question of the navigation of the air.

For several years past series of experiments upon aerial screws, both for sustaining and for propelling, have been carried on by *Commandant Renard*, at the French Aeronautical War Establishment at Chalais. He published a preliminary paper in the *Revue de L'Aéronautique*, in 1889, in which he gave a description of the machine used in testing, and of the results of the experiments with the screw of the war balloon *La France*, which is two bladed, nearly 23 ft. in diameter, with an average pitch of 27.5 ft. and a surface of about 42 sq. ft.

He found that the efficacy of this screw, or its thrust in pounds divided by the foot-pounds exerted, varied from 48.4 lbs. per horse power at 17 turns per minute, down to 16.94 lbs. per horse power, with 48 turns per minute; and he calls attention to the fact that inasmuch as the thrust increases as the square of the velocity, while the power required grows as the cube, the proper method of comparing the efficiencies of various forms of screws is to compare the quotients obtained by dividing the cubes of the thrusts by the squares of the powers.

Commandant Renard seems to have so proceeded in comparing his experiments; and in a paper read by him before the French Society of Physics, in 1889, he stated that of seven forms of screws tried up to that time, one was much better than the others; and he added from theoretical considerations: "There must be a screw for which $\frac{\text{Thrust}^3}{\text{Power}^2}$ = constant, is a maximum. This is confirmed by experiment; and it shows, moreover, that this maximum when plotted resembles a sharp peak, each side of which forms a *veritable precipice*. In other words, there is a screw very much better than others, and its form cannot be much departed from without producing very bad aerial screws."

None of the forms of screws experimented upon are published, save that of *La France*, and that this is not the best may be inferred from the fact that Mr. *Maxim*, who tested about fifty different forms of screws in his recent experiments, says: "The screw which gave the worst results was made exactly like those employed in the experiments of the French Government."

Mr. *Maxim* has published a popular account, all too brief, of his experiments, in the *Century Magazine* for October, 1891, but for obvious reasons does not go into scientific details. He has expressed the intention of eventually doing so, and this is sure to prove a very great addition to our present scanty knowledge, for his experiments on aerial screws have been more systematic and comprehensive than any heretofore tried.

From the foregoing it will be seen that comparatively few experiments have been made to compass artificial flight by means of sustaining aerial screws, and that much, very much remains to be learned concerning the best form to be given to them, the proper area, velocity and pitch, as well as the power required, either for sustaining or for propelling a given weight in the air with a screw. Indeed, even for marine screws, our knowledge may be said to be wholly empirical—that is to say, based on experiment; and there is no mathematical theory of them which has found general acceptance, or which connects their action with that of plane surfaces, so as to agree with the observed facts. Some calculations made by the present writer seem to indicate that it may be less difficult to do so, in the case of aerial screws; but it must be acknowledged that we really know but little about them, and that the most that we can say at present is that while a flying machine in which the sustaining power is to be obtained from rotating screws is likely to require less surface than an aeroplane to sustain the same weight, perhaps in the proportion of about one-third, yet it is likely to require more power than the aeroplane to obtain the same speed of translation, and also to involve greater risks of accidents in case of failure of any part of the machinery.

It would seem to the writer as if the true function of aerial screws was to propel, leaving the sustaining power to be obtained in some other way, and we will therefore pass to the consideration of AEROPLANES.

(TO BE CONTINUED.)

UNIFORM STANDARD TIME.

AT the January convention of the American Society of Civil Engineers the Committee on Uniform Standard Time—Messrs. Sandford Fleming, Charles Paine, Theodore N. Ely, T. M. Toucey and T. Egleston—presented an interesting report, from which we take the following extract:

At the annual meeting in January, 1891, the Committee reported that railroad men continued to be heard from, and that up to date a total number of 403 presidents, managers and others in the highest official positions (nearly all of whom had communicated directly with the Society) had expressed themselves in favor of the adoption of the 24-hour notation. As the aggregate length of railroad with which these officers are connected is about 140,000 miles, it appears obvious that the proposal to adopt the 24-hour notation meets with general assent, that there is no insuperable obstacle in the way of its introduction throughout North America, and that the change may be effected at any time by joint arrangement among railroad men.

The Committee reported the adoption of the 24-hour notation throughout the Indian Empire and on the short railroad mileage in China. Within the year 1890 the mileage of railroad on which the new notation had been permanently introduced had increased from less than 4,000 miles to over 20,000 miles. The Committee reported on the progress of the time reform movement in Europe, and referred to the official correspondence issued by the British Government to all the British colonies around the globe, recommending the principles of Standard Time and the new notation of the hours, which this Society has long advocated.

The Committee has now to report that during the past year the advance of the movement has been most marked in Europe. For a number of years back the question has been under discussion among scientists, in the press, and from time to time in some of the legislatures of European nations. The most remarkable speech recorded is that of the late Count von Moltke in the Imperial German Parliament at the sitting of March 16. This, perhaps the last public utterance of the illustrious and aged statesman-soldier, from the influence it has had in Europe and will continue to have throughout the world in extending the advantages of a movement in which this Society has taken a leading part, must be of interest to every member.

By the latest information from Europe it appears that the Belgian Minister of Railroads, Posts and Telegraphs has issued a notice to all the services connected with the departments, announcing that from May 1, 1892, Standard Time will be used. He invites all the railroad companies to adopt the same reckoning, and asks his colleagues in the Government to issue directions, for all services, to conform to the new reckoning in their relations with the public. The Government of Holland has likewise taken decisive action, and authorized the adoption of Standard Time based, as in Belgium, on the zone of the Greenwich meridian. This decision will come into force on May 1, 1892, for the interior service, in Dutch territory. From April next, Standard Time, based on the reckoning of the meridian 15° east, will be introduced in the States of Bavaria, Wurtemburg, Baden, and Alsace-Lorraine. Since October 1, 1891, Austria Hungary has, by official authority, adopted Standard Time in all its public services. In Prussia there has been much discussion and much difficulty, owing to a reactionary movement, but a change followed the wise views expressed in the Reichstag by the late Field-Marshal von Moltke, and now it is by Imperial direction that the adoption of Standard Time is proposed. It is not unlikely, therefore, that the proposition will be finally resolved upon at the next sitting of the Chambers.

The strange opposition of France to the general introduction of Standard Time shows signs of weakening. It is true that France still isolates herself in this matter, as she did at the Washington conference, from all the other nations who voted for the meridian passing through Greenwich as the prime meridian to be common to all. But France has made some approach to uniformity by adopting the reckoning of Paris as the time for the whole nation.

The reckoning of Paris differs from Standard Time only nine minutes, and it cannot be doubted that the good sense of the French people must eventually lead them to join their neighbors in a common system of uniformity by sacrificing the small difference of nine minutes to general expediency.

From the latest information received, it is evident that Europe is now making the first great step in time reform which America made in 1883, in introducing Standard Time into general use. In the second important step, the adoption of the 24-hour notation, this country is somewhat anticipated by India, and we need not be greatly astonished to hear of a rapid development of the reform in Europe, when once the first step is fully taken. Already in the Belgian Parliament a prominent member, M. Houzeau de Lehaie, has moved the Government to introduce the 24-hour notation.

It cannot but be a matter of congratulation to the American Society of Civil Engineers that this important movement for placing time reckoning on a proper scientific basis makes progress in so many quarters. It is recognized that this Society has been one of the first and most active prime movers, that it has greatly stimulated the movement, not in this country alone, but throughout the globe; and it cannot be doubted that the Society must eventually receive the fullest credit for the action which it has taken from the beginning.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

(*Continued from page* 185.)

TURNOUTS FROM CURVES.

In discussing turnouts from curves, we will consider the subject, for brevity's sake, as turnouts from the inside of the curve, and turnouts from the outside of the curve, without going into all the details as to the arrangement of the rails. From the foregoing discussion for turnouts from tangents, the engineer may readily determine the similar cases for curves.

Let us first take up the subject of turnouts from the inside of a curve. Two cases will be considered.

CASE I.

We will first consider the case where the main track curve is to the right, with the turnout curve likewise to the right, with the third rail on right of center, as shown in fig. 11.

LENGTH OF THROW-RAILS.

The length of the throw-rails may be determined as follows: In fig. 10 let HP represent the center line of main track and HN the center line of turnout curve, R the radius of main track, R' the radius of turnout curve, and assume PN as the throw $= \frac{1}{2}d$. Then in the triangle CBN we have the side $CN = R - \frac{1}{2}d$, $CB = R - R'$ and $BN = R'$. Let $s =$

$$\frac{R' + (R - R') + (R - \frac{1}{2}d)}{2}.$$

Then, by trigonometry, we have

$$Sin. \tfrac{1}{2}\, CBN = \sqrt{\frac{(s - R')\ (s - (R - R')}{R' \times (R - R')}}$$

and the angle

$$NBM = \frac{180° - CBN}{2}.$$

Then in the right-angled triangle NBM we have the three angles and the side $NB = R'$ given to find the side $NM = \frac{1}{2} NH$, and from trigonometry,

$$NM = Sin.\ NBM \times R'. \qquad (12)$$

Example:

Given radius main track, $R = 573.7$, the radius of turnout track $R' = 380$, and the throw 5 in. $= .417$ ft., to find the length of chord of throw-rail NH:

$$s = \frac{380 + (573.7 - 380) + (573.7 - 0.417)}{2} = 573.491$$

$s - R = 573.491 - 380 = 193.491$	2.2866607
$s - (R - R') = 573.491 - 193.7 = 379.791$	2.5795446
$R = 380.000$ ar. comp.	7.4202164
$R - R' = 193.700$ ar. comp........	7.7128704
Extracting sq. root....................	2)19.9992921
$\frac{1}{2} CBN = 87° 41'$.................*sin.*	9.9996460

from which the angle $CBN = 175° 22'$ and the angle

$$NBM = \frac{180° - 175° 22'}{2} = 2° 19'.$$

Then,

$2° 19'$...............	*sin.*	8.6066226
$R = 380$..........		2.5797836
NM 15.36′ = 15′ 4¼″.		1.1864062

from which $NH = 30' 8\frac{1}{2}''$.

The length of the arc HN may be found in the same manner as described for Eq. 7.

To find the frog angle $DAE = BAC$, fig. 11, of the first frog, given the radius of main track $= R$, the radius of the turnout $= R'$ and the standard gauge $= g$.

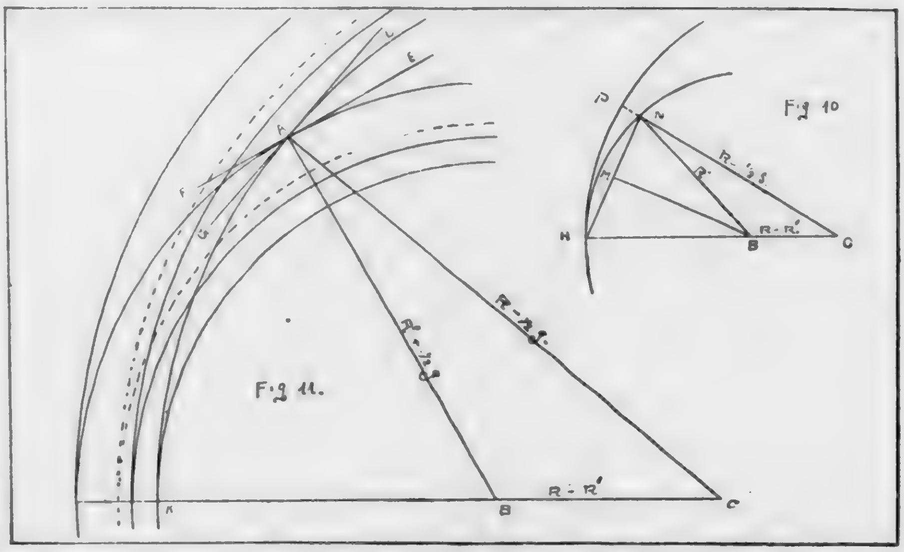
In the triangle BAC we have given the side $AC = R - \frac{1}{2}g$, $AB = R' + \frac{1}{2}g$ and $BC = R - R'$.

$$\text{Let } s = \frac{(R - R') + (R - \frac{1}{2}g) + (R' + \frac{1}{2}g)}{2},$$

then, from trigonometry, we have

$$Sin. \tfrac{1}{2}\, BAC = \sqrt{\frac{[s - (R - \frac{1}{2}g)]\ [s - (R' + \frac{1}{2}g)]}{(R - \frac{1}{2}g)\ (R' + \frac{1}{2}g)}}. \qquad (13)$$

It will be noted that in this case the result is not affected by the width of the narrow gauge g'.



Example: Given the radius of the main track, $R = 573.69$, the radius of the turnout $R' = 380.00$, and the standard gauge $= 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $DAE = BAC$, fig. 11:

$s = (573.69 - 380) + (573.69 - 2.354) + (380 + 2.354) = 573.69$

$s - (R - \frac{1}{2}g) = 2.354$........	0.3718065
$s - (R' + \frac{1}{2}g) = 191.336$	2.2817967
$R - \frac{1}{2}g = 571.336$ ar. comp....	7.2431084
$R' + \frac{1}{2}g = 382.354$ ar. comp....	7.4175343
Extracting sq root..........	2)17.3142459
$\frac{1}{2} BAC = 2° 36' 9''$.......*sin.*	8.6571229

whence the angle $B\,A\,C$ is 5° 12′ 18″—the required answer.

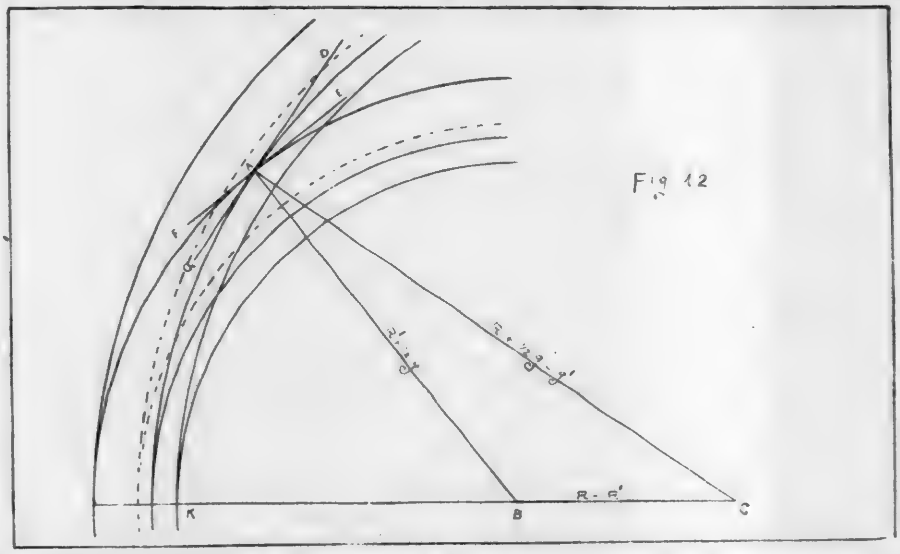
To find the frog angle $D\ A\ E = B\ A\ C$, fig. 12, of the second frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $A\,B\,C$ we have the side $A\,C = R + \frac{1}{2}g - g'$, the side $A\,B = R + \frac{1}{2}g$, and the side $B\,C = R - R'$.

$$\text{Let } s = \frac{(R - R') + (R + \frac{1}{2}g - g') + (R' + \frac{1}{2}g)}{2},$$

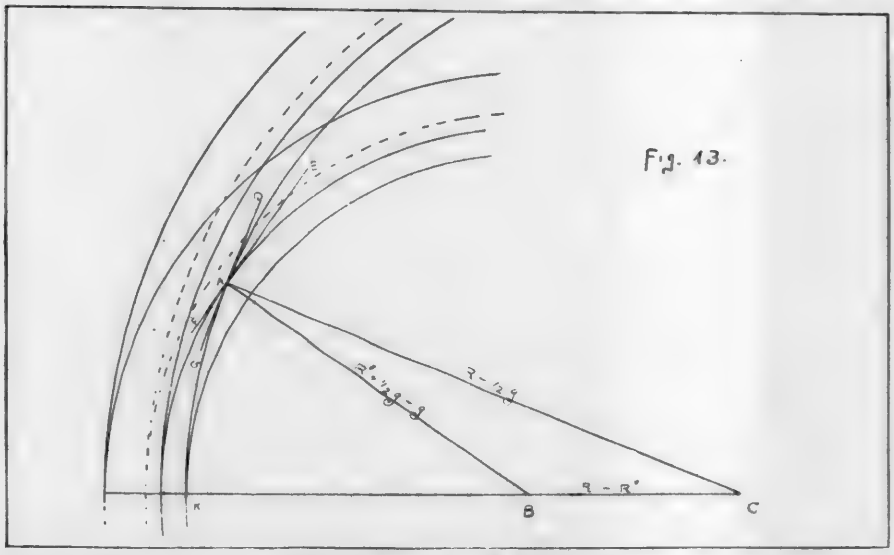
then, from trigonometry, we have

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R+\frac{1}{2}g-g')]\ [s-(R'+\frac{1}{2}g)]}{(R+\frac{1}{2}g-g')\ (R'+\frac{1}{2}g)}} \cdot (14)$$



Example No. 1: Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, the narrow gauge $g' = 3$ ft. 0 in.—to find the frog angle $D\ A\ E = B\ A\ C$, fig. 12:

$$s = \frac{(573.69-380)+(573.69+2.354-3.000)+(380+2.354)}{2} = 574.544$$



$s - (R + \frac{1}{2}g - g') = 1.500$	0.1760913
$s - (R' + \frac{1}{2}g) = 192.190$	2.2837308
$R + \frac{1}{2}g - g' = 573.044$ ar. comp.	7.2418121
$R' + \frac{1}{2}g = 382.354$ ar. comp.....	7.4175343
Extracting sq. root..........	2)17.1191685
$\frac{1}{2}\ B\ A\ C = 2°\ 4'\ 44''$. .... *sin.*	8.5595842

whence the angle $B\ A\ C$ is $= 4°\ 9'\ 28''$.

Example No. 2: Given the radius of the main track $R = 573{,}69$, the radius of the turnout $R' = 380$, the standard gauge $g = 5$ ft. 3 in. and the narrow gauge $g' = 1$ metre $= 3.281$ ft.—to find the frog angle $D\ A\ E = B\ A\ C$, fig. 12:

$$s = \frac{(573.69-380)+(573.69+2.625-3.281)+(380+2.625)}{2} = 574.674$$

$s - (R + \frac{1}{2}g - g') = 1.640$.....	0.2148438
$s - (R' + \frac{1}{2}g) = 192.049$......	2.2834120
$R + \frac{1}{2}g - g' = 573.034$ ar. comp.	7.2418196
$R + \frac{1}{2}g = 382.625$ ar. comp......	7.4172267
Extracting sq root..........	2)17.1573021
$\frac{1}{2}\ B\ A\ C = 2°\ 10'\ 19''$........*sin.*	8.5786510

whence the angle $B\ A\ C$ is 4° 20′ 38″—the answer required.

To find the frog angle $D\ A\ E = B\ A\ C$, fig. 13, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the tournout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

Here in the triangle $A\ B\ C$ we have the side $A\ C = R - \frac{1}{2}g$, the side $A\ B = R + \frac{1}{2}g - g'$, and the side $B\ C = R - R'$.

As before, let $s =$ the $\frac{1}{2}$ sum of the three sides, or

$$s = \frac{(R - R') + (R - \frac{1}{2}g) + (R' + \frac{1}{2}g - g')}{2}$$

and we have

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R-\frac{1}{2}g)]\ [s-(R'+\frac{1}{2}g-g')]}{(R'+\frac{1}{2}g-g')\ (R-\frac{1}{2}g)}} \cdot \quad (15)$$

Example No. 1: Given the radius of the main track $R = 573.69$ ft., the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D\ A\ E = B\ A\ C$, fig. 13:

$$s = \frac{(573.69-380)+(573.69-2.354)+(380+2.354-3.00)}{2} = 572.190$$

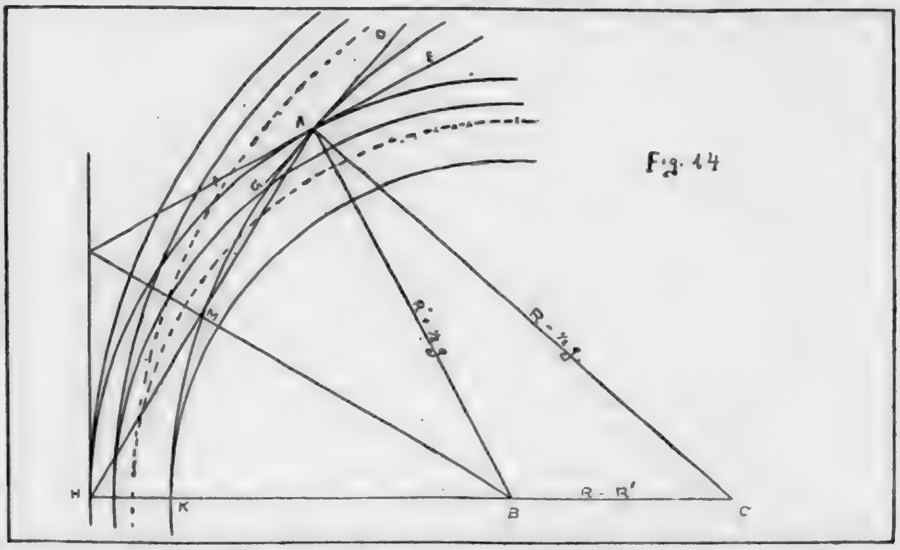
$s - (R - \frac{1}{2} g) = 0.854$..........	1.9314579
$s - (R' + \frac{1}{2} g - g') = 192.836$....	2.2851881
$R' + \frac{1}{2} g - g' = 379.354$ ar. comp.	7.4209553
$R - \frac{1}{2} g = 571.336$ ar. comp	7.2431084
Extracting sq. root..........	2)16.8807097
$\frac{1}{2} B A C = 1° 34' 46''$.........*sin.*	8.4403548

whence the angle $B A C = 3° 09' 32''$.

in the case for fig. *M*, where the third rail is on the right of the center, and hence the angles must be equal. Therefore, the angle required is found from equation 13—viz.:

$$Sin. \tfrac{1}{2} B A C = \sqrt{\frac{[s - (R - \frac{1}{2} g)]\ [s - (R' + \frac{1}{2} g)]}{(R - \frac{1}{2} g)\ (R' + \frac{1}{2} g)}}.$$

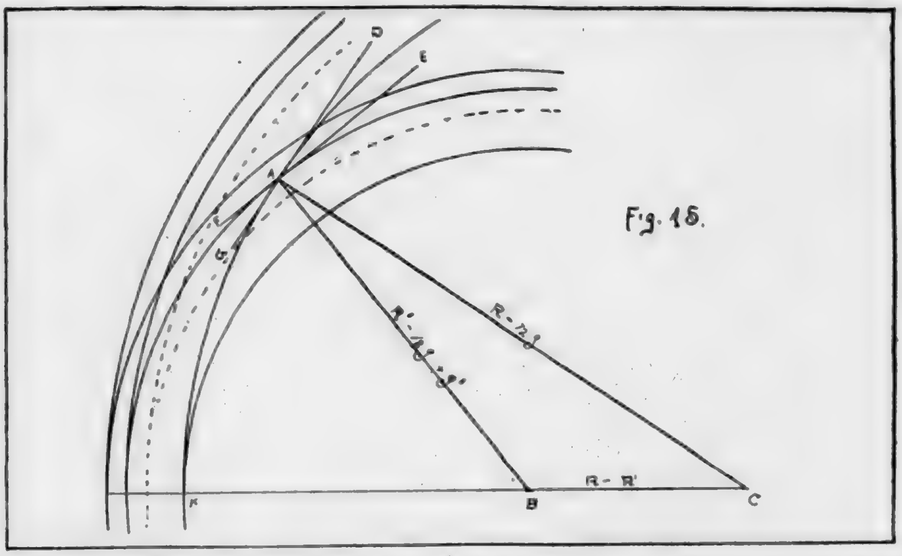
To find the frog angle $D A E = B A C$, fig. 15, of the second frog, given the radius of the main track $= R$,



Example No. 2: Given the radius of the main track $R = 573.69$, the radius of the turnout curve, $R' = 380$, the standard gauge $g = 5$ ft. 6 in., and the narrow gauge

the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B A C$ there are given the side $A C =$



$g' = 3$ ft. 6 in., to find the frog angle $D A E = B A C$, fig. 13:

$$s = \frac{(573.69 - 380) + (573.69 - 2.75) + (380 + 2.75 - 3.5)}{2} = 571.94$$

$s - (R - \frac{1}{2} g) = 1.00$..........	0.0000000
$s - (R' + \frac{1}{2} g - g') = 192.69$....	2.2848592
$R' + \frac{1}{2} g - g' = 379.25$ ar. comp..	7.4210744
$R - \frac{1}{2} g = 570.94$ ar. comp.......	7.2434095
Extracting sq. root...........	2)16.9493431
$\frac{1}{2} B A C = 1° 42' 34''$.........*sin.*	8.4746715

whence the angle sought is $3° 25' 8''$.

CASE II.

Under this case will be considered the case where the curve of the main track is to the right, the turnout to the right, with the third rail on the left of the center.

To find the frog angle $D A E = B A C$, fig. 14, of the first frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, and the standard gauge $= g$.

In the triangle $B A C$ we have given the side $A C = R - \frac{1}{2} g$, $A B = R' + \frac{1}{2} g$, and $B C = R - R'$. Thus it will be seen that the sides of the triangle are the same as

$R - \frac{1}{2} g$, the side $A B = R' - \frac{1}{2} g + g'$, and the side $B C = R - R'$.

As in previous cases, let

$$s = \frac{(R - \frac{1}{2} g) + (R' - \frac{1}{2} g + g') + (R - R')}{2}.$$

Then will

$$Sin. \tfrac{1}{2} B A C = \sqrt{\frac{[s - (R - \frac{1}{2} g)]\ [s - (R' - \frac{1}{2} g + g')]}{(R - \frac{1}{2} g)\ (R' - \frac{1}{2} g + g')}}. \quad (16)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D A E = B A C$, fig. 15:

$$s = \frac{(573.69 - 2.354) + (380 - 2.354 + 3.00) + (573.69 - 380)}{2} = 572.836$$

$s - (R - \frac{1}{2} g) = 1.5$....	0.1760913
$s - (R' - \frac{1}{2} g + g') = 192.190$..	2.2837308
$R - \frac{1}{2} g = 571.336$ ar. comp......	7.2431084
$R' - \frac{1}{2} g + g' = 380.646$ ar. comp.	7.4194788
Extracting sq. root..........	2)17.1224093
$\frac{1}{2} B A C = 2° 5' 11''$..........*sin.*	8.5612046

whence the angle sought is $4° 10' 22''$.

By comparing this result with that obtained in Example No. 1, Eq. 14, it is found that the same number of frog will answer for either of these cases.

To find the frog angle $D\ A\ E = B\ A\ C$, fig. 16, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\ A\ C$ there are given the side $A\ C = R - \frac{1}{2}g + g'$, the side $A\ B = R' + \frac{1}{2}g$ and the side $B\ C = R - R'$.

As before, let

$$s = \frac{(R - \frac{1}{2}g + g') + (R' + \frac{1}{2}g) + (R - R')}{2}.$$

Then will

$$Sin. \tfrac{1}{2} B\ A\ C = \sqrt{\frac{[s-(R-\frac{1}{2}g+g')]\ [s-(R'+\frac{1}{2}g)]}{(R - \frac{1}{2}g + g')\ (R' + \frac{1}{2}g)}}. \quad (17)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D\ A\ E = B\ A\ C$, fig. 16:

$$s = \frac{(573.69-2.354+3.00)+(380+2.354)+(573.69-380)}{2} = 575.190$$

$s - (R - \frac{1}{2}g + g') = 0.854$	1.9314579
$s - (R' + \frac{1}{2}g) = 192.836$	2.2851881
$R - \frac{1}{2}g + g' = 574.336$ ar. comp.	7.2408339
$R' + \frac{1}{2}g = 382.354$ ar. comp.	7.4175343
Extracting sq. root	2)16.8750142
$\frac{1}{2}\ B\ A\ C = 1^\circ\ 34'\ 9''$ ... *sin.*	8.4375071

Therefore $B\ A\ C = 3^\circ\ 08'\ 18''$.

It is not deemed necessary here to discuss the other cases of turnouts from the inside of curves, where the turnouts are trailing switches, as distinguished from the facing switches discussed, nor turnouts from the inside of a curve where the main track curve is to the left, with the facing and trailing switch.

From what has already been said concerning these cases where the turnouts are from tangents, it will be readily seen that the frog angles remain the same, the only difference in the frogs being in the manner of curving them.

To find the radius of the turnout curve from the inside of the curve, given the radius of the main track $= R$, the gauge $= g$, and the frog angle $D\ A\ E = B\ A\ C$, fig. 14:

In the triangle $A\ C\ H$,

$HC+AC : HC-AC :: \text{tang.}\ \frac{1}{2}HAC+AHC : \text{tang.}\ \frac{1}{2}HAC-AHC$

now, $H\ C = R + \frac{1}{2}g$

and $A\ C = R - \frac{1}{2}g$.

Hence $H\ C + A\ C = 2\ R$ and $H\ C - A\ C = g$.

The angle $H\ A\ C = H\ A\ B + B\ A\ C$ while

$H\ A\ C + A\ H\ C = 180^\circ - H\ C\ A$ and

$H\ A\ C - A\ H\ C = B\ A\ C$.

Substituting these values in the above proportion, we have

$$2\ R : g :: \text{tang.}\ \tfrac{1}{2}\ (180^\circ - H\ C\ A) : \text{tang.}\ \tfrac{1}{2}\ B\ A\ C.$$

But the tang. $\frac{1}{2}\ (180^\circ - H\ C\ A) = \text{tang.}\ 90^\circ - \frac{1}{2}\ H\ C\ A$, and from the proportion we have the equation

$$\text{tang.}\ 90^\circ - \tfrac{1}{2}\ H\ C\ A = \frac{2\ R \times \text{tang.}\ \frac{1}{2}\ B\ A\ C}{g}.$$

But since the tangent of 90° minus a given angle is equal to the cotangent of the given angle, we have, from the above, the equation

$$\text{cot.}\ \tfrac{1}{2}\ H\ C\ A = \frac{2\ R \times \text{tang.}\ \frac{1}{2}\ B\ A\ C}{g}. \quad (18)$$

This analysis (as well as that for Eq. 27) is somewhat analogous to that employed by Henck in the case where a switch angle is used, instead of regarding the whole turnout as being the arc of a circle.

Example: For finding the central angle:

Given the radius of the main track $R = 573.69$, the frog angle $D\ A\ E = B\ A\ C = 5^\circ\ 12'\ 18''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the central angle $H\ C\ A = B\ C\ A$, fig. 14:

$2\ R = 1147.38$	3.0597073
$\frac{1}{2}\ B\ A\ C = 2^\circ\ 36'\ 09''$ ... tang.	8.6575669
$g = 4.708$ ar. comp.	9.3271635
$\frac{1}{2}\ H\ C\ A = 5^\circ\ 9'\ 30''$ ... cot.	1.0444377

whence the angle required, $H\ C\ A = B\ C\ A = 10^\circ\ 19'\ 00''$.

Having thus found the angle $H\ C\ A$, the remaining one $C\ B\ A = 180^\circ - (B\ A\ C + A\ C\ B)$.

It now remains to find the side $A\ B$ in the triangle $A\ B\ C$, fig. 14. Here there are given the three angles and one side, $A\ C = R - \frac{1}{2}g$, to find $A\ B = R' + \frac{1}{2}g$.

$$R' + \tfrac{1}{2}\ g = \frac{R - \frac{1}{2}\ g \times Sin.\ B\ C\ A}{Sin.\ C\ B\ A}. \quad (19)$$

Example: Given the radius of the main track $R = 573.69$, the frog angle $D\ A\ E = B\ A\ C = 5^\circ\ 12'\ 18''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the radius R' of the turnout curve, fig. 14.

Having found from Equation 18 the angle $B\ C\ A = 10^\circ\ 19'\ 00''$, and then the angle $C\ B\ A = 164^\circ\ 28'\ 02''$, we proceed as follows:

$R - \frac{1}{2}\ g = 571.336$	2.7568916
$B\ C\ A = 10^\circ\ 19'\ 00''$ ... *sin.*	9.2530675
$C\ B\ A = 164^\circ\ 28'\ 42''$ ar. comp. .. *sin.*	0.5725094
$R' + \frac{1}{2}\ g = 382.356$	2.5824685

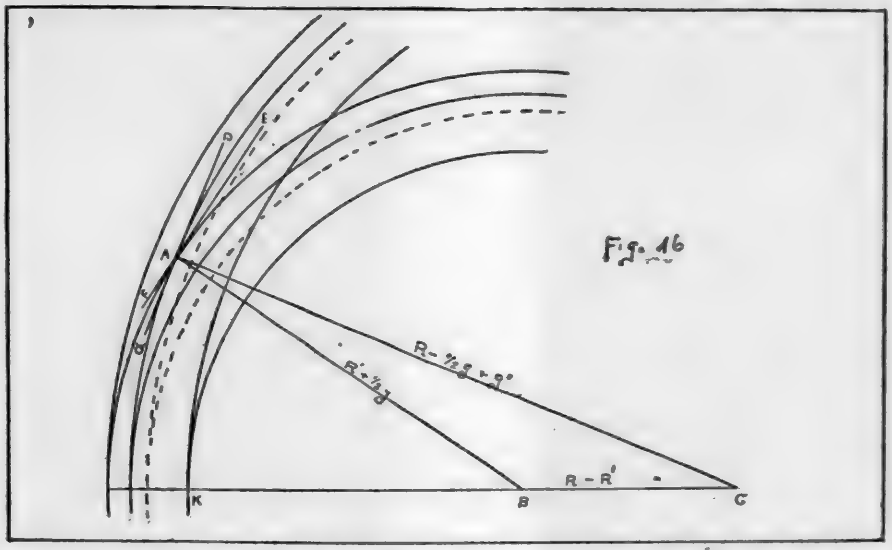


Fig. 16

Subtracting from this result the value of the $\frac{1}{2}$ gauge $= 2.354$, we have as the radius of the turnout 380 002.

THE CHORD DISTANCE.

Having thus found the radius of the turnout curve, the chord distance $H\ A$, fig. 14, may be readily found.

The angle $H\ B\ A = 180^\circ - C\ B\ A$, the angle $M\ B\ A = \frac{1}{2}\ H\ B\ A$, and $B\ A\ M = 180^\circ - (B\ A\ M + M\ B\ A)$. Thus in the right-angled triangle $A\ B\ M$ we have the three angles and the side $A\ B = R' + \frac{1}{2}\ g$ given to find the $\frac{1}{2}$ chord distance $A\ M$.

From trigonometry,

$$A\ M = (R' + \tfrac{1}{2}g) \times Sin.\ M\ B\ A. \quad (20)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the main track $R' = 380$, and the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the chord distance $H\ A$.

The angle $H\ B\ A = 180^\circ - 164^\circ\ 28'\ 42'' = 15^\circ\ 31'\ 18''$ and

$$M\ B\ A = \frac{15^\circ\ 31'\ 18''}{2} = 7^\circ\ 45'\ 39''.$$

$R + \frac{1}{2} g = 382.354$	2.5824657
$M B A = 7° 45' 39''$ ....sin.	9 1304568
$A M = 51.633$	1.7129225

whence $H A = 103.266$.

To find the length of arc $H A$ from the heel of the switch to point of frog, fig. 14:

If it be desired to find the length of the arc measured along the outer rail of the turnout curve from the heel of the switch to point of frog, we may proceed in a manner analogous to that employed for Eq. 8.

Thus, in fig. 14 represent the central angle $H B A$ by b, the radius $B A = R + \frac{1}{2} g$ by r; then will the whole arc of which r is the radius be equal to $2 r \pi$, and the part of the arc included by the central angle b must be given by the equation

$$\text{Arc } H A = 2 r \pi \frac{b}{360°}.$$

Example:

Let $b = 15° 31' 18''$
$r = 382.354$

$2 (R + \frac{1}{2} g) = r = 764.708$	2 8834957
$\pi = 3.1416$	0.4971499
$b = 15° 31' 18'' = 55878''$	4 7472409
$360° = 1296000''$ ar. comp	3.8873950
Arc. $H A = 103.581$	2.0152815

In a similar manner to the above may be found the arc along this outer rail from the heel of the switch to point of the frog for any other case where the turnout is from the inside of the curve.

(TO BE CONCLUDED.)

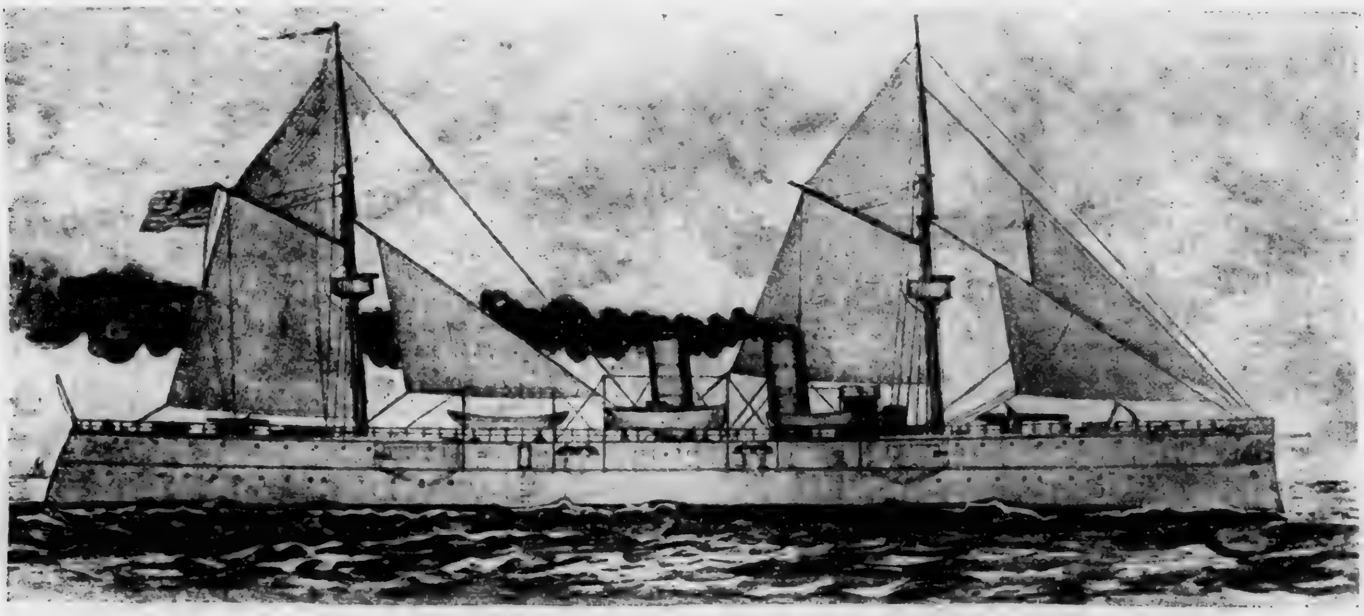
THE UNITED STATES NAVY.

THE next new ship to be launched will be the practice cruiser for the Naval Academy, which the S. L. Moore & Sons Company is building in its yard at Elizabeth, N. J. It was expected that this vessel would be launched about April 30.

IT is stated that the Navy Department is preparing plans for a new armored cruiser resembling the *New York*, but with some modifications from that ship. It is probable that Congress will authorize the building of a vessel of this class at anyrate, even if no other new ships are put in the Naval Appropriation Bill.

LAUNCH OF THE "RALEIGH."

THE new cruiser *Raleigh* was successfully launched at the Norfolk Navy-Yard, March 31, with appropriate ceremonies, a number of officers and invited guests being present. The *Raleigh* is one of the 3,000-ton cruisers, the building of which was authorized in 1888. The other ship of this class, the *Cincinnati*, is now under construction at the New-York Navy-Yard, where also the engines for both ships are being built. The accompanying view of this ship is taken from the Report of the Bureau of Construction of the Navy Department.



CRUISER "RALEIGH," UNITED STATES NAVY.

The *Raleigh* is an unarmored steel cruiser, the only protection consisting of a protective deck, of the arrangement of the coal bunkers, and of coffer-dams filled with cellulose surrounding the engines and magazines. The general dimensions are: Length, 300 ft.; extreme breadth, 42 ft.; mean draft, 18 ft.; displacement, 3,180 tons.

She has twin screws, each driven by a triple-expansion engine with high-pressure cylinders 36 in.; intermediate, 53 in., and two low-pressure cylinders, each 57 in. in diameter, all being 33-in. stroke. These engines are expected to work up to 10,000 H.P. with forced draft, and to give the ship a speed of 20 knots. There are four main boilers, double-ended, and two auxiliary boilers, single-ended.

The main battery will include one 6-in. breech-loading rifle, mounted on the forecastle, and ten 5-in. rapid-fire guns, two mounted on the poop and the others on the gun deck. All of these guns will be protected by steel shields. The secondary battery will consist of eight 6-pounder rapid-fire guns, and of two Gatling guns mounted in the tops. There will also be six torpedo-tubes arranged for Howell torpedoes.

The ship will carry a full electric light plant, consisting of two engines and dynamos, and will be provided with three search-lights.

The engine power of these ships is high in proportion to their size, and they are expected to be fast ships and very useful cruisers.

THE CELLULOSE TRIALS.

THE Board which had charge of the trials of cellulose as a protection for ships has made a preliminary report, and it is understood that the results have been satisfactory enough to warrant the Navy Department in ordering the adoption of this material for the three battle-ships—the cruisers *New York* and Nos. 12 and 13.

The contracts for these vessels call for the use of either cellulose or woodite, as may be determined by the Department. Cellulose will be the material used, though on account of its tendency to become foul when damp, the

coffer-dams built inside of the steel hulls back of the armor protection will not be filled with the material until there is danger of hostilities. The cellulose will be kept on hand in convenient form to be placed in a vessel whenever needed. In the plans for these vessels provision is made for this buoyancy protection material. As a result of its experience in connection with the experiments, the Board submits the following conclusions and recommendations:

1. The cellulose used in coffer-dams for obturating purposes should be packed loose, and great care taken to obtain the required specific gravity, when packed, of 0.12.

2. In packing the coffer-dams, compression should be obtained by means of jacks or other appliances, by which the pressure is applied gradually and evenly. The cellulose should never be rammed or treated in a manner calculated to pulverize it.

3. A thorough and uniform mixing of granular and fibrous cellulose is essential if the best results are to be obtained. To receive this it would seem desirable that the cellulose be mixed at the manufacturer's works and supplied at the ship-yards ready for use.

4. In order to insure durability of the material, the coffer-dam compartment must be made watertight. The Board recommends that they be tested in the most thorough and rigid manner by repeatedly filling with water under a moderate pressure until found to be absolutely watertight, being afterward thoroughly painted inside and out.

5. Although not absolutely essential, it is believed that the most satisfactory results will be obtained when the top of the coffer-dam is made removable, or in cases where this is impracticable, where there is a manhole in every frame space. Under these circumstances it is possible to obtain the requisite compression of the cellulose with much greater certainty than when one manhole must be used for filling the length of several frame spaces of the coffer-dams.

SEA-COAST BATTERIES.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 160.*)

THE DISAPPEARING GUN-CARRIAGE.

THAT guns can no longer be fought without cover and in the open is fully conceded by engineer and artilleryman alike. In the United States, to secure the needed protection for our guns, they propose to give us the disappearing gun-carriage—that is, a mount that shall retain the gun below the parapet during the process of loading, and only bring it into view while it is being pointed and fired.

The exact character of the mount has not yet been fully decided upon, but in general terms it may be said that two distinct types are proposed—one the disappearing carriage proper, the other the gun lift. The former, without going into details, can be described as suspending the gun from the extremities of two strong metal arms in its proper relation to the parapet over which it is to fire; that when fired it is thrown out of equilibrium by the force of recoil, and under the action of this force and its own weight it sinks below the parapet. At the same time, the energy developed by the recoil is, by means of proper appliances, stored up in the form of compressed air, a compressed metal spring, or, as in the case of the counterpoise carriage, of a raised counter-weight. When the force of recoil is exhausted and the gun is in a proper position for loading, it is caught automatically and there held. By opening a valve, releasing the spring, or by bringing the counter-weight into action, the gun is raised to its original position for firing. With the gun lift, the gun, and its carriage are raised vertically for firing from its position below the parapet by hydraulic or other machinery, and lowered by the same means after it has been discharged. The lift is proposed for all guns of over 10-in. caliber.

It will be seen that while the gun is in its firing position it is wholly without protection, and that even when below the parapet the protection secured both for the gun and the men who serve it is more apparent than real. When the disappearing carriage was first invented, muzzle-loading guns were in use, and in their service the ammunition supply and almost the entire gun detachment were under cover. With breech-loading guns of great length the cannoneers must perform their duties from 30 to 50 ft. back from the parapet, and without overhead protection of any kind; so that, except for security against direct fire, the personnel of a battery are no better off than they were thirty years ago.

Let us see how the conditions of attack and defense have changed during this time, it being taken for granted that the improvement in heavy guns for ship and for shore batteries has been about equal.

For the attack (1) the introduction of machine and quick-firing guns in large numbers on board of war-ships of every class, and the consequent enormous increase in the possible volume of fire; (2) increased facilities for obtaining ranges, and (3) increased power of shell.

It is difficult to appreciate the extent to which machine and quick-firing guns have come into use on board the modern war-ship. On board the new English battle-ships we shall find, in addition to the four 67-ton guns of the main battery, secondary and auxilliary batteries of ten 6-in. and 24 other quick-firing guns. The *New York*, when finished, will have, besides her six 8-in. rifles, 24 quick-firing guns from 1-pdrs. to 4-in., and 4 machine guns; and so on through the navy list of every civilized power.

The amount of metal that can be thrown by guns of this character in a limited space of time will be understood when we remember that the 6-in. Armstrong (100-pdr.) has been fired on board ship, changing aim after each shot, ten shots in a little more than two minutes; that the 4.7-in. Armstrong (45-pdr.) and the corresponding caliber Canet gun can fire six aimed or twice as many unaimed shots per minute; that Krupp's 27-pdr. can fire ten, and his 76-pdr. seven aimed shots in the same time; that the 37-mm. Hotchkiss can be fired 80 shots per minute, each projectile weighing 1 lb. and giving from 10 to 12 useful fragments, or about 800 fragments per minute, with a maximum range of about 5,000 yds.

Quick-firing howitzers must now be added to the weapons against which open batteries will in future have to contend. The Grüson (4.72-in.) 36-pdr. quick-firing howitzer can fire 10 shots per minute at an elevation of 35° and a range of 6,000 yds. The English are about adopting a quick-firing howitzer, and many of the large English war-ships now building are to have at least one of these guns at the bow, mounted for high-angle fire.

When we remember that all but the largest calibers of these quick-firing guns have mounts that admit of great elevation or of curved fire, and the great number of guns of this kind even a moderate sized fleet will carry and can bring to bear upon any particular point within a 6000-yard range, or greater, a very little calculation will show what a veritable rain of projectiles can be delivered—projectiles or fragments that may not be able to dismount a gun, but are amply sufficient, with their angle of fall, to search out the gunners behind the parapet and to disable the delicate attachments of a disappearing gun-carriage. As pertinent to the question of high-angle fire from ships, against which the open battery is practically defenseless, it is well to call attention to the fact that last year the English naval authorities made a successful experiment with a 9.2-in. high-power rifle mounted on the gunboat *Handy* upon a Vavasseur carriage of peculiar construction. Elevations from zero to 30° were employed without undue strain upon the ship's deck.

The Fiske and other range finders have been brought to such a degree of perfection that there should be little difficulty in locating the position of shore batteries, or in their absence, the lighter guns may be relied upon to determine the range. Besides, the captain of a ship in approaching any well-known harbor is not feeling his way over untrodden ground. On the contrary, a competent pilot, or, say, the master of any one of the scores of foreign ships that weekly come into the port of New York, is, one may say, familiar with every foot of ground from Scotland Lightship to his dock in Hoboken or Jersey City. With a properly prepared chart before him, with his lead on the

bottom and his ranges on shore his own position is a matter of certainty, as is that of any located point on shore, as of a battery or group of batteries; and he has this advantage, that while his adversary's position is fixed and always known, by keeping under way, his own is never the same from one moment to another.

It must be admitted by any one familiar with the effect of shrapnel that if a reliable time fuse were at hand, the power of the attack as against open batteries would be increased many fold. That we shall have such a fuse in the near future seems to be beyond a doubt. The Chief of Ordnance in his report for the present year announces that they have found a reliable combination time and percussion fuse and are experimenting with a mechanical time fuse. To obtain the maximum effect of shrapnel fire against gunners or material, a time fuse that will explode the projectile in the air above or in front of the objective point is necessary, but even percussion shell or shrapnel can do murderous work.

To meet these undisputed gains in the power of the attack, our military engineer proposes (1) the disappearing gun; (2) mine defense, and (3) mortar batteries. The disappearing gun-carriage has been called the fad of the day with the engineer and ordnance officer, and takes the lead; yet the Chief of Ordnance in his last reports laments that no satisfactory carriage of this description has as yet been devised. Of the various proposed types, the pneumatic carriage now on the proving ground at Sandy Hook seems to be the most in favor. This is described as being of such complicated construction as to require an expert engineer to run it; and just now, owing to the breaking of a cog-wheel during some experimental firing, it is laid up for repairs.

The gravest objection to this class of gun-mounts is that, outside the fact that they do not afford the required protection to the personnel, they are all more or less complicated and easily disabled. To lift a hundred tons of metal, more or less, from behind a parapet surely and quickly, and then to swing or lower it back again behind its cover, bespeaks such strength of material, so perfect an adjustment of parts, such perfection of detail, that one can be pardoned for being thoroughly skeptical both as to its mechanical practicability as well as the wisdom of trusting so costly a product as a heavy high-power rifle to the keeping of a contrivance that even a bit of shell or a shrapnel bullet may put out of order. Captain Chester, in writing of the necessity of simplicity in all the appliances and methods to be employed in time of war, very truly says: "War is a rough business, and is conducted in a rough way by rough and often awkward men. Delicate instruments and flimsy fittings are out of place in it. There should be no chance for the gunner to disable his own gun, and as little chance as possible for the enemy to do it. If possible, there should be nothing about it that will break, as strength and simplicity are prime requisites in all warlike machines."

A summary of Lieutenant Fletcher's Report on European Naval Ordnance Material applies equally to that for land service:

> Present tendencies abroad indicate a speedy return to hand power for gun mountings, with a limited use of steam or electricity. Considered simply as machines, hydraulic mountings are perfect, but they are not fitted to the adverse conditions of sea service and actual war. . . . The life of the gun, as it were, hangs by a thread, which may be severed by a most trivial and unforeseen cause; and it is a question if the gun is not in as much danger of being disabled by the complicated character of its mountings as by the fire of the enemy.

If in a mount of the kind proposed a pump fails to work, a cog-wheel is broken, a truck gets out of gear, a lever or valve fails to perform its perfect function, your gun goes out of action as surely as if bowled over by a thousand-pound shot.

The extent to which submarine mines will modify the former conditions of attack and defense of seaports is hard to say. It is believed they have been given an exaggerated value. An attacking fleet, provided with all the modern appliances for countermining and clearing a channel, would be little handicapped provided the fire of the defense could be controlled or silenced, as it most surely would be if reliance is placed wholly or in large part upon open batteries of any kind.

In our present scheme of coast defense mortar batteries have been given a very prominent place. No one can deny the disastrous effect of a heavy mortar shell upon the deck of the strongest ironclad, and the wonderful accuracy obtained in practice firing with the rifled mortar is admitted. But when, instead of known distances, clear skies, and the utmost deliberation, we have a target enveloped in smoke, whose position and distance is largely a matter of guess, it is believed that the hitting of such an object will be purely a matter of chance; besides, if the position of such batteries are known—as there is no reason to doubt they will be—it will be within the power of the attack to make the efficient service of this class of guns, which must always be in open batteries, as hazardous if not as impossible as that of rifles upon disappearing mounts.

In considering a scheme of defense that takes such risks with its material alone, it must not be forgotten that in the modern plan of sea-coast armament we have not, as in the days of smooth-bore guns, fifty, a hundred, or perhaps several hundred guns in a single work, or to defend a single approach, when the loss of even a dozen guns was not a matter of vital import, but, on the contrary, a number that is relatively very small; nor that, almost without exception, the naval gun's crew is provided with cover that is at least proof against machine-gun fire and shell splinters.

In connection with this question of relative armament under the old and new conditions, it is interesting to recall what was considered necessary in *ante-bellum* days. In an elaborate report made in 1851, by General Totten, Chief Engineer of the Army, upon "A System of National Defense," we find that, including works already completed, under construction, and those planned for, an aggregate of 1,327 guns and mortars was provided for the defense of New York, of which about two-thirds were for the Southern approach. The allowance made by the Board of Fortifications in 1886 for the same purpose is 95 guns and 144 mortars. For the defense of Boston we find 763 guns and mortars deemed necessary against 43 guns and 132 mortars under the allotment of 1886. Under the same scheme Hampton Roads was to be provided with 538 and Fort Adams with 414 guns and mortars. According to General Totten's estimate, 12,685 guns were required for the Atlantic and Gulf Coasts, at an estimated additional cost for construction and armament of nearly $33,000,000. The estimate of 1886 for covering the same ground was for 1,012 guns and mortars, and an expenditure of about $76,000,000. It should be remembered that under the old system of casemate works all but absolute protection was provided for guns and gunners against the ordnance of the day for a very large percentage of the guns mounted.

The problem of sea-coast defense is a large one, the proper solution of which cannot be overestimated in importance. What has been said has been inspired by a belief in the real danger of committing ourselves so entirely to open batteries as we seem to be doing.

The line upon which this question should be solved is not difficult to discern. That we must construct at all points thoroughly shot-proof armored batteries is not claimed. It is claimed, however, that overhead cover, sufficiently strong to be proof against shell splinters and machine-gun projectiles, is absolutely necessary, if we expect to be able to fight our guns.

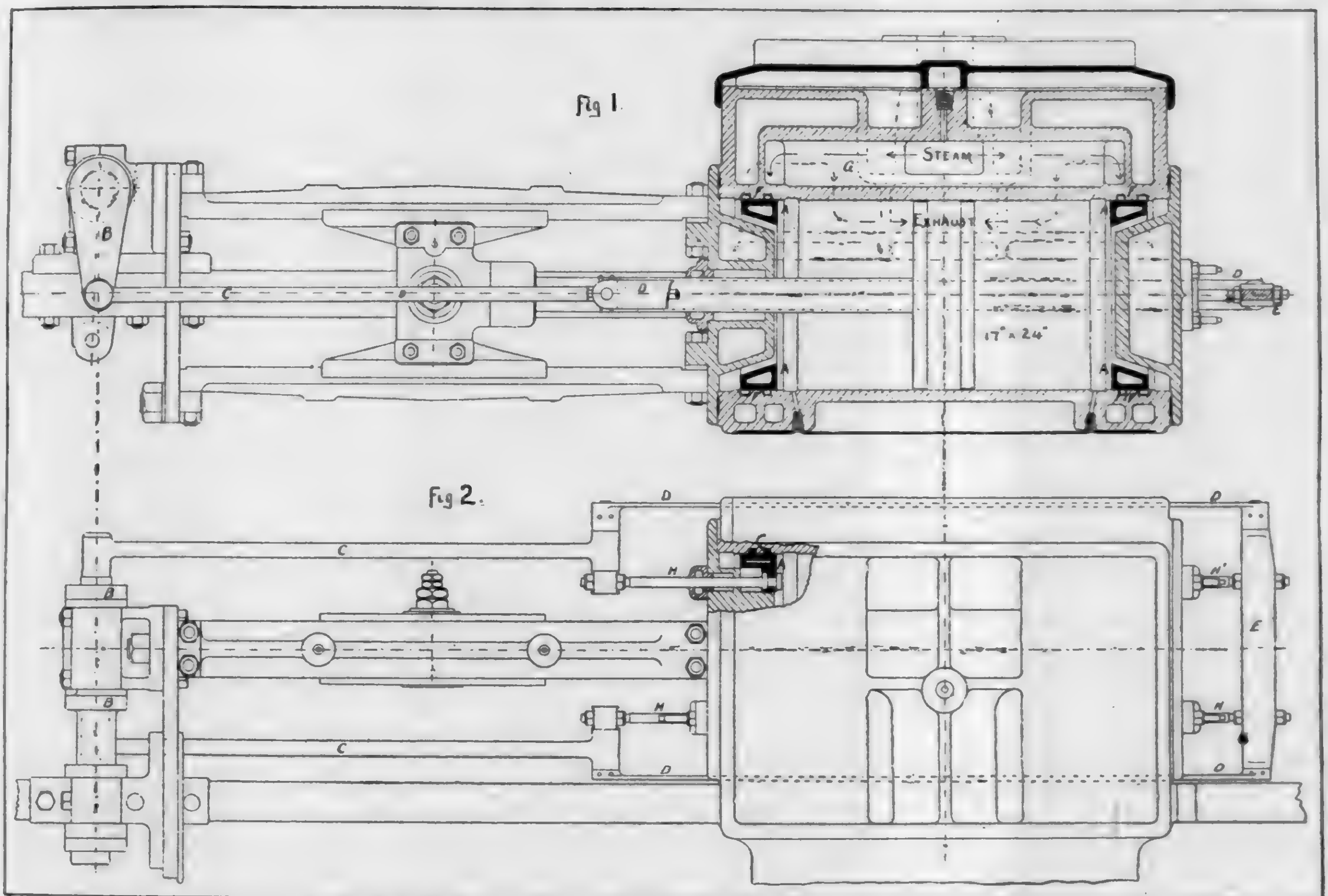
The English propose in one way to meet this question with what they call "open battery shields," in which the cover is a 2-in. steel plate properly supported by girders and covered with a layer of concrete and earth, or the batteries are so prepared that in case of need they can be quickly covered with timber or iron, or both.

At all important points and in exposed positions iron-protected batteries are believed to be those the modern conditions of war demand. If the question of greater cost is raised, it may be truthfully stated that a single gun perfectly protected will, in time of need, be of infinitely greater value than an open battery of many guns, and at the same time, considering the expensive character of the disappearing mount, will have the item of cost in its favor.

War is a trade in which one cannot with safety stop to question the cost of one's tools, although it must be admitted that this is a truth the average law-maker finds it hard to comprehend.

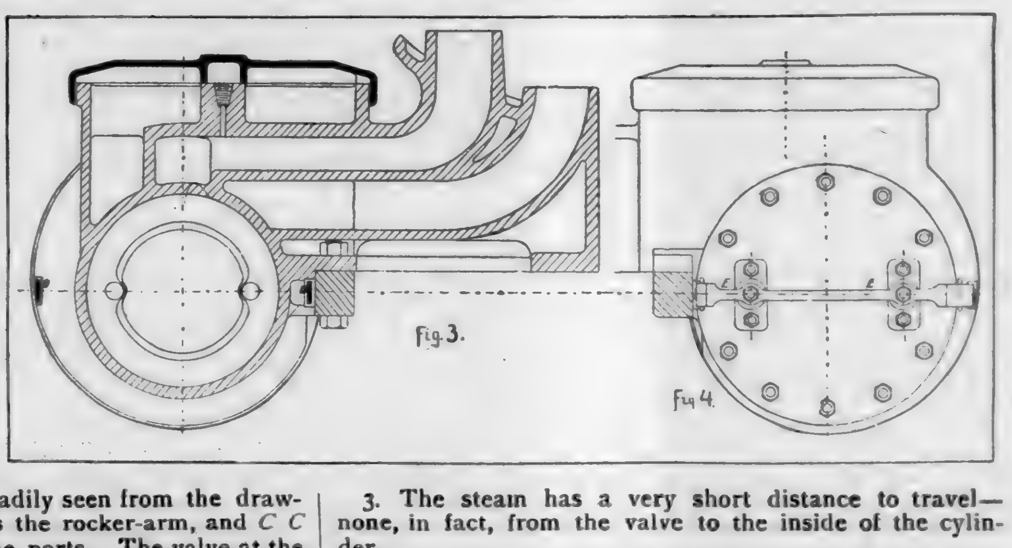
A NEW VALVE FOR LOCOMOTIVE CYLINDERS

In the JOURNAL for January, 1889, pages 43 and 44, there was described a new form of valve for steam-engines devised and patented by Mr. F. D. Child, of West Newton, Mass.; the drawings given herewith show this valve as



CHILD'S PISTON VALVE ON A LOCOMOTIVE CYLINDER.

applied to a locomotive cylinder. Fig. 1 is a longitudinal section of the cylinder and cross-head; fig. 2, a plan; fig. 3, a cross-section through the center of the cylinder, and fig. 4, an end view showing the front head. The drawings show a 17 × 24-in. cylinder arranged to replace a cylinder and steam-chest of the ordinary pattern on a locomotive which has been already in service.



The peculiar features of this arrangement, which is especially adapted for high speeds, are that the valves, which are of the piston type, are not in a separate steam chest, but in the cylinder itself. The ports run entirely around the cylinder and the valves are annular in form, consisting of a ring in each end of the cylinder. The method of working them is readily seen from the drawings; *A A* are the valves; *B* is the rocker-arm, and *C C* are the valve-rods; *F F* are the ports. The valve at the back end of the cylinder is worked directly from the valve-rods by the two valve-stems *H H*; that at the forward end is worked by the valve-stems *H' H'* from the cross-head *E*, which is connected to the valve-rods *C C* by the two flat connecting rods *D D*, one on each side of the cylinder. They may also be worked by having two rockers, one at each end of cylinder. There is a second bearing for the rocker, which is bolted to guide-yoke, as shown. In this case the engine has the form of guides and cross-head shown, but the arrangement can readily be adapted to double guides and a box cross-head.

The arrangement of the steam and exhaust-ports is shown in section in fig. 3.

While the valves shown are simply piston-valves of an annular form, the objects which the inventor has sought to accomplish by their position and arrangement are:

1. The valves are perfectly balanced.

2. They admit steam at once around the whole circumference of the cylinder.

3. The steam has a very short distance to travel—none, in fact, from the valve to the inside of the cylinder.

4. The steam is admitted and exhausted through separate ports, so that the steam-port is not cooled by the exhaust.

5. The travel of steam is always in the same direction in the ports.

6. There is no loss of steam in the ports at each stroke, the clearance in the cylinder ends being only a little more than usual; the amount depending on the closeness of construction and possibility of running.

7. The admission and exhaust-ports throughout are of great capacity.

The amount of work required to fit up this valve is not greater than that required for a cylinder with the ordinary slide-valve; it is less, in fact, if the absence of a steam-chest is considered. These valves may be fitted with packing, same as piston, if desired.

A SHOP CORNER.

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The overhead carriage and tightening arrangement keep the belt tight on the milling machine at all times and in any position, and when it is run along the lathe-bed. The milling machine carries end mills, spiral cutters, emery wheels, drill chucks, etc., and is thus a tool of universal use.

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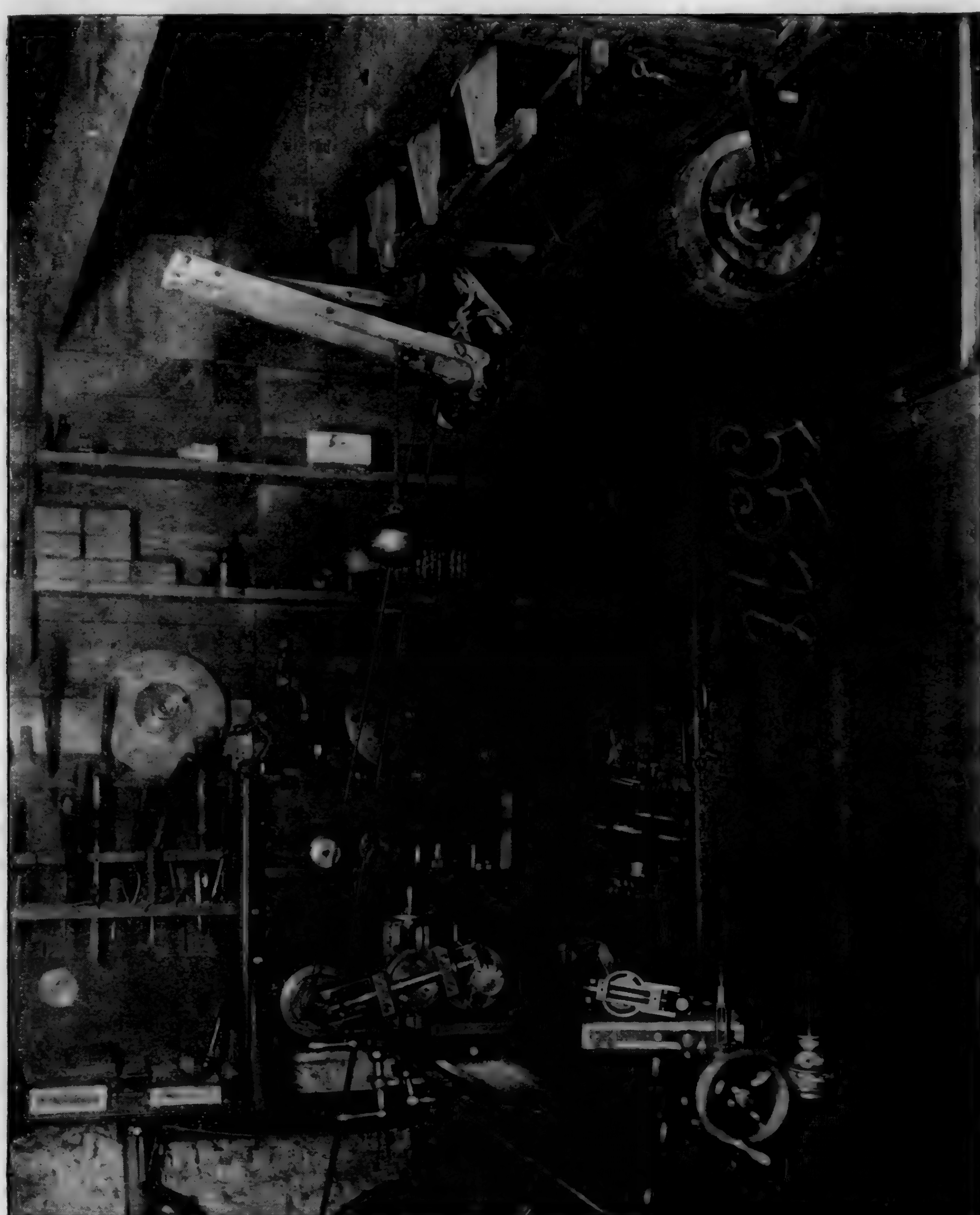

BELT-TIGHTENER AND OVERHEAD ARRANGEMENT FOR MILLING MACHINE.

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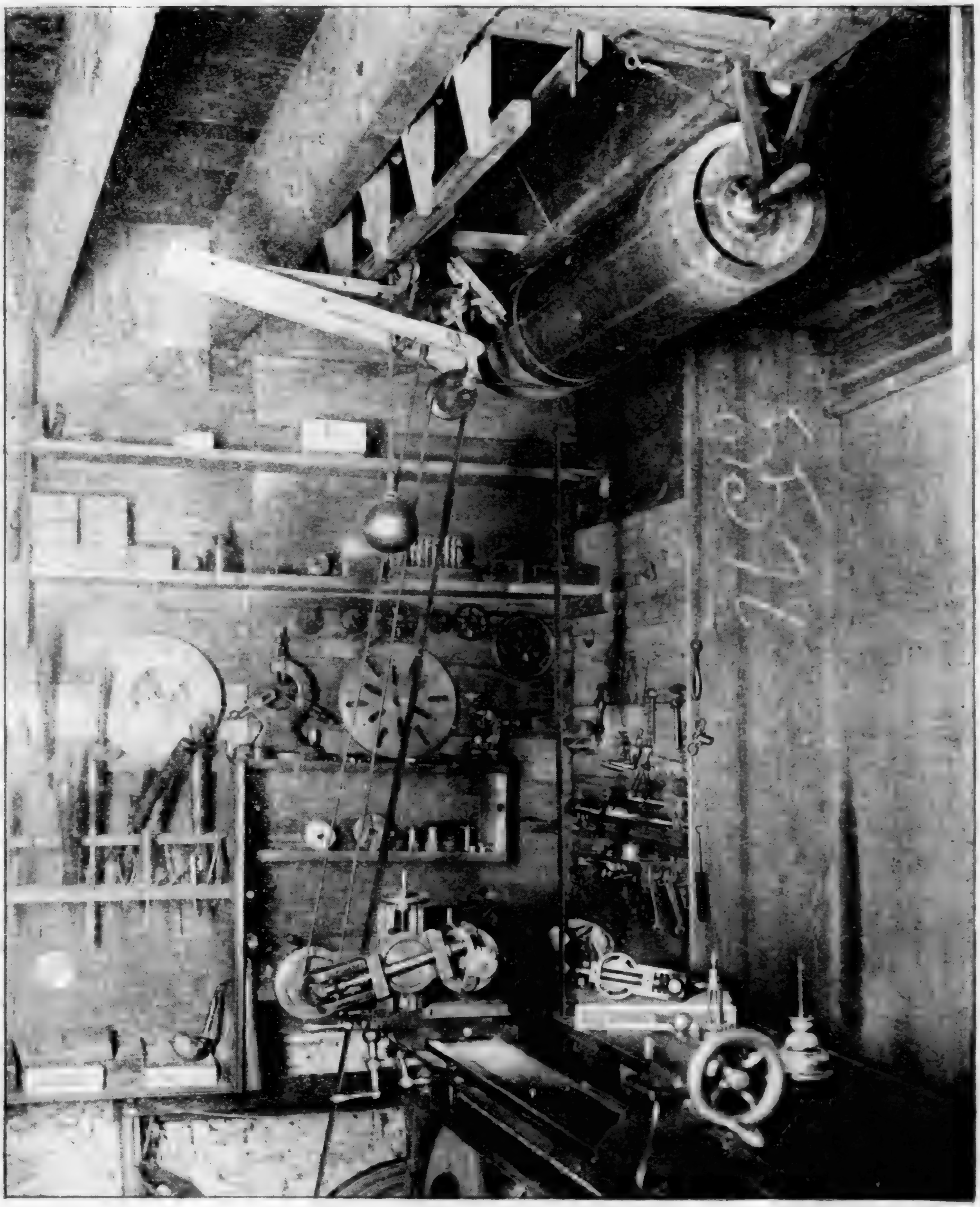

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for their stocks and bonds. How could a compulsory statute with a penal provision be made to apply to a company under such circumstances?

I have trespassed upon your attention beyond the usual limit of time, but I have been urged to do so by my desire to use this opportunity to defend the railroad companies against the charge of indifference to the welfare of their employés. I have sought to show that whatever has been accomplished in this matter of safety couplers has been the work of the railroad companies; that it has been accomplished as rapidly as the state of the art would permit, and that their organized action through the American Railroad Association has rendered unnecessary compulsory legislation on safety couplers.

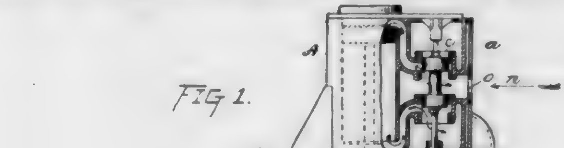
Recent Patents.

SEE'S COMPOUND ENGINE.

THE drawings herewith show an arrangement of valves for compound engines covered by patent No. 469,455, issued to Horace See, of New York, the well-known marine engineer. As shown, it is applied to an ordinary compound engine, but it is equally well adapted to a triple-expansion or quadruple-expansion engine.

In the drawings fig. 1 shows in side elevation a vertical compound engine with cylinders tandem, the steam-chests being shown in vertical cross-section, exposing the main valves to view. Fig. 2 shows in plan the relative arrangements of the cylinders and their steam-chests and the exhaust-pipe connecting the two steam-chests.

The letter *A* indicates the high-pressure cylinder; *B*, the low-pressure cylinder, of a large diameter; *C*, the piston-rod which connects the respective pistons of said cylinders, and *D*, the



SEE'S COMPOUND ENGINE.

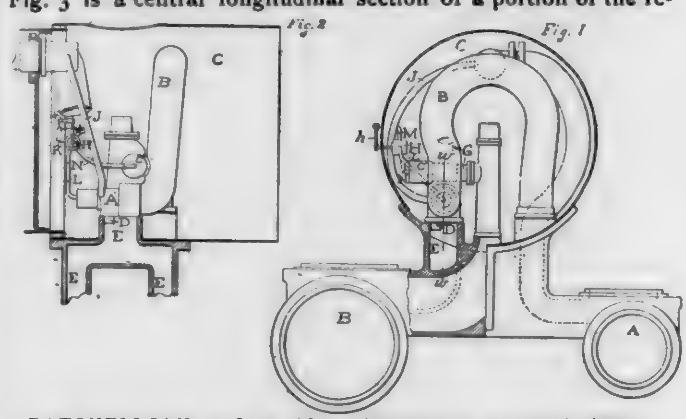
continuation of said rod, or the low-pressure piston-rod passing through the bottom of cylinder *B* and secured to the cross-head *E*. The usual connecting-rod between said cross-head and the crank *T* is omitted as unnecessary to the illustration of the invention. The two cylinders are tied together by the top frames *F* and by the exhaust-pipe *F'*, which pipe connects the respective steam-chests *a b* of the two cylinders *A B*. The housing or frames F^2 support the cylinders and all of the superstructural parts above said frames. The piston-valves *c d* are of the usual form of piston-valve, and their valve-stems *f f'* are connected by valve-rods *e g*, respectively, to arms secured on opposite sides of the beam or rock-shaft *G*. To one end or arm of said beam or rock-shaft is articulated a rod, *H*, which at its opposite or lower end is also articulated to the eccentric-rod *K*, secured in the usual manner by a strap to the eccentric *h* on the main shaft *S*. Said eccentric-rod between the eccentric and its outer end is suspended by a link on a movable center and connected by a system of rods and levers to a bell-crank or rock-shaft, *m*, which rock-shaft is connected by one of its arms and the rod *l* to the cross-head of a reversing enging, *L*. This reversing gear thus connected to said reversing engine illustrates what is known as the radial gear or so-called Marshall valve-gear. It is obvious now that upon a reciprocating motion being imparted to the rod *H* that the beam or rock-shaft *G* will be caused to vibrate upon its center, thereby reciprocating the valves *c d* by means of their respective valve-stems and valve-rods *f e f' g*, the lower valve *d* rising as the upper valve *c* descends, and *vice versâ*. The steam entering the upper steam chest *a*, as indicated by the arrow *n*, through the nozzle *o*, will thus enter the upper cylinder through the center of the piston-valve and escape from said cylinder when exhausted at the ends of said valve, whence it passes downward, as indicated by the arrow *p*, through the exhaust-pipe *F'* into the steam-chest *b*, whence said steam enters the low-pressure cylinder *B* from the ends of the valve *d* and is exhausted therefrom through the central portion of said valve, as indicated by the arrow *q*, into the condenser or into the atmosphere, as may be desired. In fig. 1 the exhaust-steam passes around the cylinder *B* into the rear frame F^2, which, as a hollow column, serves to conduct the exhaust-steam downwardly into the condenser *M*.

The advantages of this gear are the simplicity and convenient arrangement of the parts, and the fact that none of the packing in any of the valve-stem stuffing-boxes is subjected to the high pressure of the steam coming direct from the boiler, but to only the pressure of the steam after having been at least once exhausted after doing work in a cylinder. This is due to the admission of the initial high-pressure steam only into the interior of the valve of the high-pressure cylinder.

BATCHELLOR'S VALVE FOR COMPOUND LOCOMOTIVES.

The drawings given here show a valve for compound locomotives which is used by the Rhode Island Locomotive Works, and which is covered by patent No. 459,851, issued to C. H. Batchellor, of Providence, R. I.

Fig. 1 is a front view, partly in section, of a locomotive engine, showing these improvements applied thereto. Fig. 2 is a side elevation of the forward end of a locomotive engine, showing the arrangement of the parts embodying the invention. Fig. 3 is a central longitudinal section of a portion of the re-



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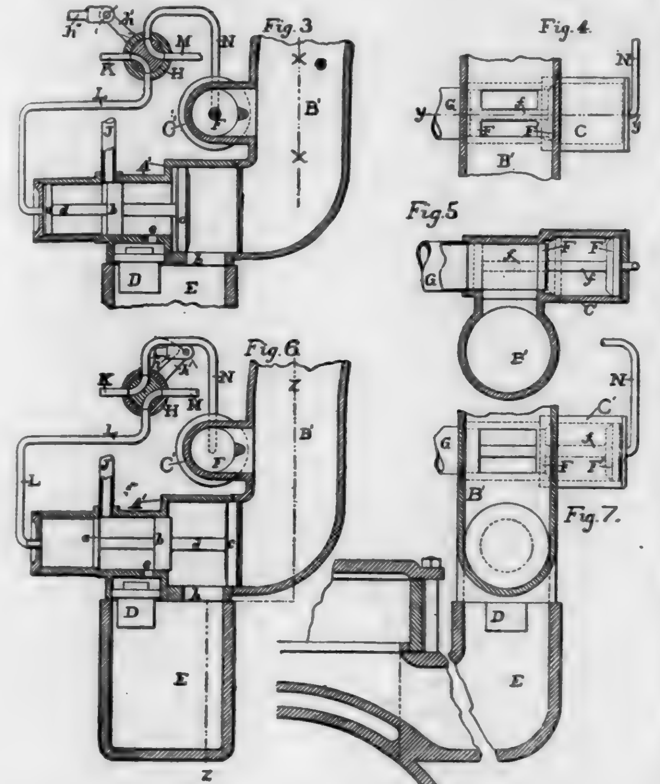
ceiver which connects the high and low-pressure cylinders and of the mechanism connected therewith, the section being taken on the line *w w* of fig. 1. Fig. 4 is a section through the receiver on the line *x x* of fig. 3. Fig. 5 is a section taken on the line *y y* of fig. 4. Fig. 6 is a central longitudinal section of the receiver and connected mechanism corresponding to fig. 3, but showing the operative parts in another position; and fig. 7 is a section taken on the line *z z* of fig. 6.

A represents the high-pressure cylinder and *B* the low-pressure cylinder, which are of different diameters and arranged upon opposite sides of the engine, as common.

Arranged within the smoke-box *C*, and leading from the exhaust-port of the high-pressure cylinder to the steam-chest of the low-pressure cylinder is the connecting pipe or receiver *B'*. Connecting with the receiver *B'* is a cylindrical chamber, *A'*, in which are arranged to work three piston-valves *a b c* of different diameters, all secured to a common valve-rod, *d*, as shown in figs. 3 and 6. Communicating with this chamber is a pipe, *J*, which connects with the main steam-pipe. Arranged at the

side of the receiver B' is another cylindrical chamber, C', within which work two piston-valves F F' of different diameters, both mounted on a common valve-rod, f, as shown in fig. 5. A pipe, G, communicating with the chamber C', leads to the atmosphere.

H is a four-way controlling-valve, which has four pipes,



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K L M N, communicating therewith. The pipe K leads to the atmosphere; the pipe L communicates with the chamber A', as shown in figs. 3 and 6; the pipe M communicates with the boiler, and the pipe N communicates with the chamber C'. Said controlling-valve, H, is provided with a handle, h', which may be operated by means of a rod, h^2, extending to the cab.

E is a steam-pipe, which communicates with the steam-chest of the low-pressure cylinder, and e is an opening through the wall of the chamber A', which communicates with the steam-passage E through a reducing-valve, D, said reducing-valve being preferably of a character to reduce the steam from the boiler in proportion to the difference between the areas of the pistons of the high and low-pressure cylinders, respectively; h is another opening through the wall of the chamber A' for connecting the pipe E with the receiver B', as shown in figs. 3 and 6.

The changes in operation described below may be made automatically at certain pressures, or by the action of the engineer.

In operation, when the throttle-valve is opened, the valves a, b and c will be thrown into the position shown in fig. 6, and steam direct from the boiler will be admitted to the steam-chest of the low-pressure cylinder, somewhat reduced in pressure, however, by the reducing valve D. Both cylinders will then work at high pressure until the accumulated exhaust in the receiver B' reaches a determined pressure, when the valves a, b and c will be thrown back into the position shown in fig. 3, and the engine will work as a compound.

This illustration shows the object of the valve, which is to enable the engine to use high-pressure steam in both cylinders when needed, and to work as a compound at other times.

Foreign Naval Notes.

THE new cruiser *Thule* was recently launched in Sweden. She is an armored cruiser of 3,070 tons displacement, and of the low freeboard turreted type. The armament will include two 25-cm. and four 15 cm. guns, several light small rapid-fire guns and a torpedo tube.

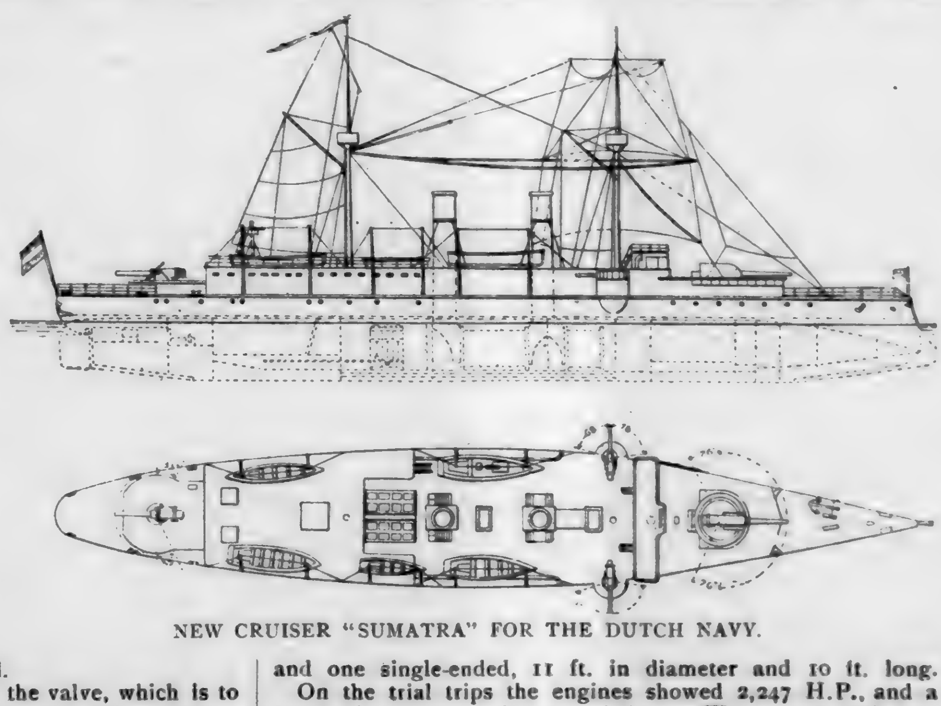
THE Japanese Government has decided to order from Sir W. G. Armstrong & Company, at Elswick, England, a cruiser of about 3,600 tons displacement. This ship is to have engines of 15,000 H.P., and a contract speed of 23 knots an hour.

ONE of the largest battle-ships of the English Navy, the *Ramillies*, was launched recently from the yard of J. & G. Thomson, at Clydebank, England. She is one of the eight ships authorized in 1889, four of which are being built by contract, and the remaining four in English dockyards. She is an armored battle-ship 380 ft. long, 75 ft. beam, and 27 ft. 6 in. mean draft, having 14,150 tons displacement, and engines which are expected to give her a speed of 17½ knots. The protection consists of a belt of compound steel plates 250 ft. long, 8½ ft. wide, and 18 in. thick, with transverse armor bulkheads fore and aft of the machinery space, and a steel deck 3 in. thick. Above this there is a second belt plate of 4-in. steel plates for a length of 150 ft. amidships. The armament will consist of two 13½-in. 67-ton guns, mounted in two barbettes rising several feet above the upper deck, composed of compound plates 18 in. thick. In addition to these, there will be ten 6-in. rapid-fire guns, 25 small rapid-fire and machine guns, and seven torpedo-tubes. The two screws will be driven by two triple-expansion engines having cylinders 40 in., 59 in., and 80 in. in diameter and 51 in. stroke, and there will be 8 boilers working at 150 lbs. pressure. The *Ramillies* will have two masts, each provided with fighting tops.

A DUTCH CRUISER.

The accompanying illustrations, from *Industries*, are a side elevation and deck plan of the cruiser *Sumatra*, lately completed at Amsterdam, and intended for service in the East Indies. She is a steel cruiser with a protective deck covering the engines, etc., while further protection is given by a belt of cellulose extending the whole length of the ship, and by the arrangement of the coal bunkers. The dimensions are: Length over all, 233 ft.; beam, 37.5 ft.; depth, 23.3 ft.; mean draft, 14 ft.; displacement, 1,703 tons. The armament consists of one 21-cm. (8.3-in.) gun forward; one 15-cm. (5.9-in.) gun aft, and two 12-cm. (4.7-in.) guns mounted in sponsons, one on each side. There are also several small rapid-fire guns and two torpedo-tubes.

The *Sumatra* has two screws, each 9 ft. diameter. There are two vertical triple-expansion engines, with cylinders 25 in., 35 in. and 55 in. in diameter and 22 in. stroke. There are two double-ended boilers 11 ft. in diameter and 17 ft. long, and one single-ended, 11 ft. in diameter and 10 ft. long.



NEW CRUISER "SUMATRA" FOR THE DUTCH NAVY.

On the trial trips the engines showed 2,247 H.P., and a speed of 15.5 knots with natural draft. With forced draft they developed 2,749 H.P., and a speed of 16.3 knots was reached.

LOCOMOTIVE RETURNS FOR THE MONTH OF JANUARY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	64	53	51,200	85,296	32,202	168,208	3,183	....	....	....	....	....	79.68	....	6.69	5.20	5.60	0.23	0.40	6.30	2.00	19.73	....	....	....
Alabama & Vicksburg	19	16	18,473	14,942	12,068	45,483	2,843	....	....	....	....	....	70.42	....	6.57	2.80	6.00	0.24	0.80	6.10	0.60	17.54	....	....	....
Atchison, Top. & Santa Fé	708	....	....	....	325,608	1,981,531	2,799	....	....	....	....	....	90.21	....	....	5.79	7.89	0.30	0.20	6.80	1.73	22.71	....	....	1.67
Beech Creek	35	29	15,194	67,343	19,400	101,937	3,515	....	39.30	49.00	102.88	83.33	91.12	....	....	2.22	5.69	0.44	....	5.31	0.60	14.26	....	....	1.25
Canadian Pacific	580	....	481,548	913,956	285,517	1,681,021	2,898	....	....	....	....	....	80.40	....	....	3.77	14.32	0.46	....	5.52	1.33	25.40	....	2.25	3.52
Chic., Burlington & Quincy	494	....	....	....	....	1,839,609	3,727	4.74	16.84	....	....	....	94.79	....	....	4.67	6.77	0.23	0.44	6.81	....	18.92	....	....	1.41
Chicago & Northwestern	846	....	650,823	1,329,165	609,558	2,589,546	3,061	....	....	....	....	....	89.93	....	....	3.57	8.53	0.37	....	6.28	0.89	19.64	....	....	1.88
Cincinnati Southern	106	102	79,618	162,563	69,314	311,495	3,054	....	....	....	....	....	88.89	....	7.38	4.00	5.90	0.26	0.80	6.50	1.60	19.06	....	....	....
Cleve., Cinn., Chic., & St. L.	....	478	419,497	652,013	355,321	1,426,826	2,985	4.30	19.80	81.73	124.84	73.58	98.96	18.62	6.31	2.96	6.57	0.19	1.63	6.64	0.21	18.20	....	....	1.31
Cumberland & Penn.	23	21	5,154	31,057	....	36,211	1,724	....	....	....	....	....	90.90	....	....	6.65	4.90	0.40	....	....	2.10	14.05	....	....	....
D., L. & W., Main Line	207	198	....	....	....	575,029	2,904	....	....	....	....	....	94.34	....	....	3.53	6.86	0.39	....	5.61	....	16.39	....	....	....
Morris & Essex Div.	156	....	161,293	254,354	12,255	427,902	2,743	....	....	....	....	....	64.17	....	....	3.38	10.00	0.53	....	6.26	....	19.97	....	....	3.08
Flint & Père Marquette.	....	....	87,828	157,794	54,054	299,676	....	....	....	....	....	....	52.63	....	....	2.42	6.95	0.33	....	6.15	....	15.85	....	....	2.00
Kan. City, F. S. & Mem.	150	....	102,899	271,486	125,671	500,056	3,334	....	....	....	....	....	68.33	....	....	3.18	5.94	0.24	0.54	7.09	....	16.99	....	....	1.69
Kan. City, Mem. & Birm.	41	41	37,317	61,616	7,110	106,043	2,586	....	....	....	....	....	70.80	....	....	3.03	3.49	0.82	....	6.85	....	14.19	....	....	0.95
Lake Shore & Mich. South	570	560	434,182	905,033	584,144	1,923,359	3,374	....	....	71.20	97.75	38.76	74.07	....	....	2.79	5.89	0.11	0.06	7.31	0.17	16.33	....	....	1.58
Louisville & Nashville	....	369	419,394	800,159	369,532	1,589,085	3,608	5.01	15.08	66.33	116.98	51.21	86.50	13.35	7.47	4.85	6.94	0.26	1.50	6.15	0.64	20.34	3.30	1.60	1.59
Manhattan Elevated	....	282	777,181	....	64,595	841,776	2,985	....	....	....	....	....	46.51	....	....	1.80	9.40	0.30	....	8.70	....	20.20	....	....	3.97
Mexican Central*	146	120	....	....	....	396,523	3,304	....	....	....	....	....	64.56	....	....	5.06	17.02	0.42	0.15	5.97	0.93	29.55	....	....	5.60
Mil. L. S. & West.	112	101	76,730	144,411	63,181	284,322	2,815	....	....	....	....	....	89.24	....	....	3.24	13.52	0.27	....	6.34	0.98	24.35	....	....	3.00
Missouri Pacific	339	....	....	....	....	1,154,960	3,407	4.24	17.32	....	....	....	101.21	19.61	7.02	4.66	7.20	0.33	1.36	6.66	1.39	21.60	4.69	1.43	1.41
N. O. & Northeastern	38	31	27,172	53,737	24,357	105,266	3,396	....	....	....	....	....	80.32	....	6.14	4.30	7.50	0.26	0.90	6.50	1.50	21.06	....	....	....
N. Y., Lake Erie & West.	....	618	436,964	1,010,162	315,199	1,762,325	2,852	4.60	19.40	94.50	137.30	77.70	....	20.70	7.10	4.91	7.98	0.42	2.48	7.37	1.16	24.32	....	1.97	1.38
N. Y., Pennsylvania & Ohio	....	261	140,539	435,213	141,375	717,127	2,748	5.10	16.50	87.60	133.00	74.20	....	17.00	8.00	4.37	7.09	0.32	3.30	6.91	1.09	23.08	....	2.09	1.25
N. Y., Prov. & Boston	....	91	103,249	46,858	58,074	208,181	2,288	....	....	....	....	....	53.53	....	....	2.88	10.59	0.52	....	6.61	0.95	21.55	....	....	....
Old Colony	....	213	301,469	115,785	114,863	532,117	2,494	....	....	....	....	....	61.61	....	....	3.32	11.55	0.65	....	6.90	0.82	23.24	....	....	3.75
Philadelphia & Reading	....	....	440,065	775,455	512,031	1,727,551	....	....	....	....	....	....	84.80	....	....	4.33	4.75	0.33	....	5.75	0.39	15.55	....	....	....
South. Pacific, Pacific Sys.	....	700	....	....	....	1,619,598	2,314	....	....	....	....	....	66.65	....	....	5.08	18.30	0.38	1.74	7.33	1.86	34.69	....	....	5.7[illegible]
Union Pacific	1032	....	763,104	1,531,500	555,856	2,850,460	2,762	5.08	16.09	....	....	....	107.00	17.39	9.01	7.36	8.33	0.45	0.91	8.12	1.07	26.25	4.44	2.08	1.55
Vicksburg, S. & P.	24	14	17,556	9,392	9,121	36,069	2,576	....	....	....	....	....	68.26	....	7.00	5.10	8.90	0.23	0.70	6.20	2.40	23.53	....	....	....
Wabash	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Wisconsin Central	159	140	135,365	243,685	54,890	433,940	3,099	....	....	....	....	....	92.47	....	....	3.79	11.37	0.26	....	7.17	....	22.59	....	....	2.41
YEAR ENDING DEC. 31, 1891.																									
Del. L. & W., Main Line	208	206	....	....	....	7,377,912	35,815	....	....	....	....	....	84.28	....	....	3.37	6.49	0.42	....	5.85	....	16.13	....	....	....
L. S. & Mich. South	560	539	4,887,406	8,583,727	6,220,942	19,692,075	36,525	....	....	[illegible].56	91.41	35.45	66.84	....	....	4.66	5.18	0.16	....	6.91	0.19	17.10	....	....	1.55
Mexican Central*	140	115	....	....	....	4,678,144	40,679	....	....	....	....	....	63.64	....	....	5.24	17.81	0.55	0.25	6.29	0.94	31.08	....	....	5.73

* The Mexican Central Railroad reports 16.6 units of work per $1 of expense; 172.4 units of work per ton of coal; 11.6 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track. For the year 1891 the report shows 16.6 units of work per $1 of expense; 171.3 units of work per ton of coal; 11.7 lbs. of coal per unit of work.

Manufactures.

The Meneely Tubular Journal Bearing.

THE accompanying illustrations show a new form of journal bearing, in which the ordinary lubricating box is replaced by steel rollers. Fig. 1 is a general view of the whole bearing, and fig. 2 is a section showing the arrangement of the rollers.

This bearing is composed of steel tubes *I R* grouped closely, though not in contact with each other, about and in alignment with the journal and enclosed within a steel-lined cylindrical

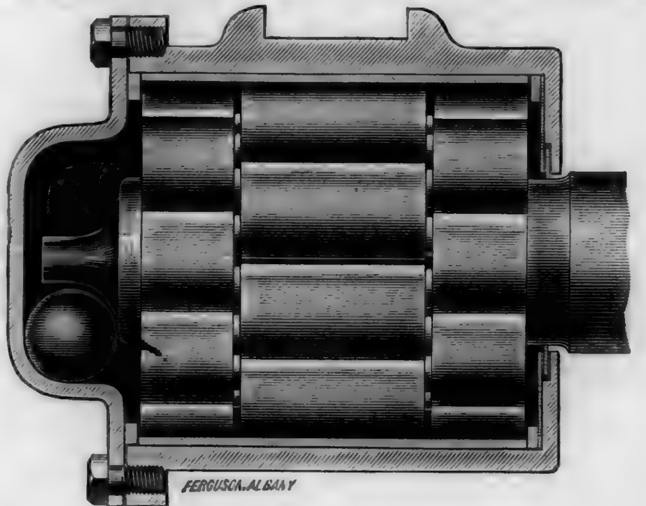


Fig. 1.

THE MENEELY TUBULAR JOURNAL BEARING.

housing or journal-box *H*. These tubes are arranged longitudinally in three series, the center series being of double length. Each short tube is in axial line with the corresponding tube of the opposite end series, while exactly intermediate to these end lines are arranged the axes of the center series. Every center tube, therefore, overlaps the adjacent end tubes. Through the alternating, opposite concavities thus formed by the interiors of the tubes, strong rods *R'* of steel are passed which lock the

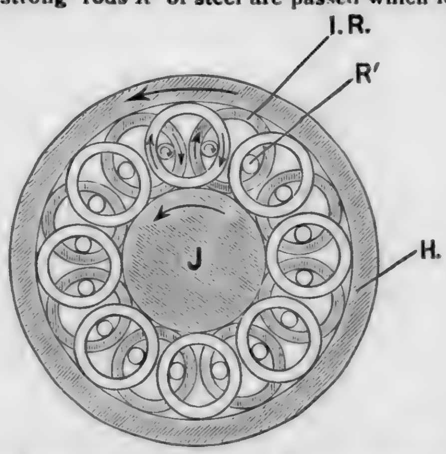


Fig. 2.

rollers in fixed position with respect to each other, and are, themselves, reciprocally held by the rollers. The arrows in

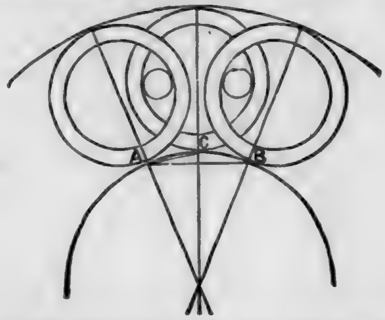


Fig. 3.

fig. 2 show the directions in which the axle and the rollers respectively revolve.

The advantage gained by the intermeshed tubular rollers is shown by fig. 3. When full length rollers were employed the adjacent bearing lines were at the points *A* and *B*; while that portion of the journal included between its perimeter and the chord *A B* represents the destructive wedging force exerted, and which had hitherto been one of the obstacles to the construction of a successful roller bearing. By making the rollers in sectional lengths, and so placing them that they break joints, intermediate bearing lines are created, as at *C*, thus securing the practical continuity of the bearing and reducing the wedge line to the chord *A C*, which is nearly coincident with the curve of the journal.

The bearing is certainly simple in form, and includes very few parts. The tubes are of steel of the best quality, and are of sufficient strength to resist crushing.

The end thrust of the axle is provided against by receiving its impact upon a steel ball seated in a groove formed in the head of the journal-box or housing, and a corresponding recess in the end of the journal, so that every movement of the journal is controlled by rolling appliances.

This bearing, which is made by the Meneely Bearing Company, of West Troy, N. Y., has been carefully tested in service. The Albany Railway has had 32 of its heavy electric cars fitted with these bearings, with results so satisfactory that 10 more have recently been added to the number.

Baltimore Notes.

THE arch-work in the Howard Street tunnel of the Belt Railroad, between the German Street and Saratoga Street shafts, has been completed. The tunnel is now finished from Lombard Street to a point north of Franklin Street, a distance of more than 2,700 ft. Work is in progress on the east wall of the tunnel south of Lombard Street, an opening having been made at the corner of Liberty and Lombard. The west wall from Lombard to Dover Street has been finished. When the east wall is built the arch will be put on by taking up the bed of the street, connecting the tunnel with the open cut south of Camden Street. There are now only five headings available from the ground work in the main tunnel, north and south from Preston Street shaft, north and south from Madison Street shaft, and north from Franklin Street. It is expected to complete the road within the year. Representatives of foreign holders of Baltimore & Ohio securities have been inspecting the road during the past two days. They are surprised at the large amount of work that has been done, and speak with praise of the engineering skill displayed in the construction of the tunnel. They speak approvingly of the strength and solidity shown in every part of the structure. Mr. H. B. Reid, Chief Engineer to the contractors, took the party through the tunnel, every detail of which was carefully examined.

THE Central Railroad Company has awarded the contract for the entire electrical equipment of its line to Mr. Davies Murdoch, representing the Thompson-Houston Electric Company. The contract for rails has been given to the Johnson Company, of Johnstown, Pa. The construction of the road will be commenced at once, and it is hoped to have it operated in July. The electrical equipment contract includes motors, generators, and line work. Some 20 motor cars will be placed on the road to be run at intervals of three minutes. Each car will be supplied with two 25-H.P. motors of a new type, waterproof and ironclad. The speed will be 10 miles an hour. Each car will hold more than 100 persons. The heaviest grade of rails—80 lbs. to the yard—has been selected. The car-stable on East Preston Street will be transformed into a power-house. The roof will be raised and the interior remodelled. The waiting-rooms and offices will occupy the front of the building on Preston Street. In the rear of the apartments will be the car-house for storing cars not in use. Separate compartments will be provided for the generators, engines, boilers, and coal-bins. The boiler-room will contain three 300-H.P. boilers. In the generator-room there will be one 200-H.P. generator and two of 250 H.P., the latter coupled together. In the engine-room will be a single 250-H.P. engine and a double engine, each unit of which will be rated at 250 H. P. All the engines are compound. The arrangement of engines and generators is made to avoid delay in case of accidents to the machinery. The single engine will operate the single generator, and the coupled generators can be worked together or singly by the double engine, which can be worked as one or in sections. An improved switch-board and lightning arresters will be included in the equipment.

WORK on the Madison Avenue line of the City Passenger Railway Company is advancing well. All the iron work on the west track is completed from Druid Hill Park to Eutaw

Street, and the paving has been done as far as North Avenue. The west track will be completed to Baltimore Street, and then the east track will be taken up. E. D. Smith & Son, the contractors, expect to build from 1,500 to 2,000 ft. of track a day when the weather is favorable and two gangs of workmen can be employed. The work on the cabling of the Blue Line, it is stated, will commence July 1.

THE Maryland Steel Company at Sparrow's Point has established a code of weather signals, by means of the big steam whistle at the iron ore furnaces, so that the residents of the Point and the farmers on Patapsco Neck for miles around can be informed of the probable condition of the weather for the next 24 hours. The company receives the weather bulletin from Washington daily, and shortly after the hour of noon the whistle announces the probabilities by the following code: One long blast, fair weather; two long blasts, rain or snow; three long blasts, local rain; one short blast, lower temperature; two short blasts, higher temperature; three short blasts, cold wave coming.

These signals are now in operation. The system, it would seem, might be useful in other places.

A New Sight-feed Lubricator.

THE illustrations below show a sight-feed lubricator for locomotive cylinders made by the Michigan Lubricator Company, of Detroit. Fig. 1 is a side view, showing the manner of attachment to the boiler, and fig. 2 is a front view. The different

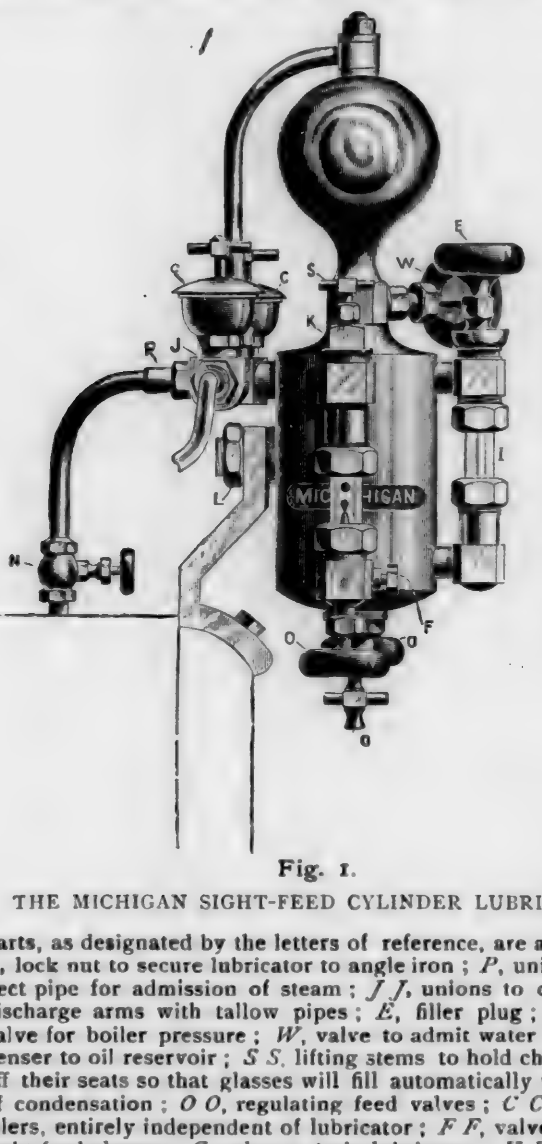


Fig. 1.

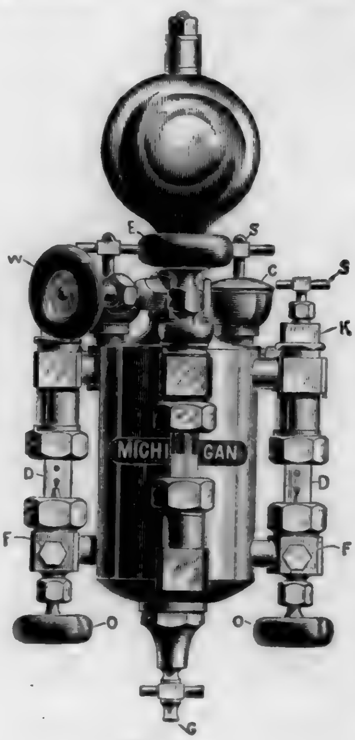


Fig. 2.

THE MICHIGAN SIGHT-FEED CYLINDER LUBRICATOR.

parts, as designated by the letters of reference, are as follows: *L*, lock nut to secure lubricator to angle iron; *P*, union to connect pipe for admission of steam; *J J*, unions to connect oil discharge arms with tallow pipes; *E*, filler plug; *N*, steam valve for boiler pressure; *W*, valve to admit water from condenser to oil reservoir; *S S*, lifting stems to hold check valves off their seats so that glasses will fill automatically with water of condensation; *O O*, regulating feed valves; *C C*, auxiliary oilers, entirely independent of lubricator; *F F*, valves to drain sight-feed glasses; *G*, valve to drain lubricator; *K K*, removable plugs or renewing or cleaning sight-feed glasses; *I*, gage glass; *D D*, sight-feed glasses.

The advantages claimed for this device are that it has drain valves at the bottom of the sight-feed glass, which will allow the engineer to drain the glasses and refill them with fresh condensation automatically, without first emptying the oil reservoir; it has check valves at the top of the sight-feed glass to close automatically should the glass break; it has means to hold the valves off their seats when it is desirable to rush steam through the glasses; it employs neither external nor internal equalizing tubes; it gives continuous equalizing and unvarying feed whether the throttle-valve is open or closed; it feeds its oil against continuous boiler pressure; finally, the glasses can be easily and quickly renewed.

General Notes.

THE Duncan Locomotive & Car Brake Company has been organized in East St. Louis to manufacture brakes and other appliances.

THE Steel Works of the West Superior Iron & Steel Works, West Superior, Wis., are now in operation, having been running the converters for some little time. The Company will manufacture Bessemer steel plate and structural shapes. The plant was built by the Pittsburgh Iron & Steel Company, and Mr. W. F. Mattes has charge of its operation.

THE Baldwin Locomotive Works, in Philadelphia, have an order for 21 compound engines of the Vauclain type for the Philadelphia & Reading Railroad.

THE Barney & Smith Manufacturing Company, in Dayton, O., are building 1,000 box cars for the Cleveland, Columbus, Cincinnati & St. Louis Railroad.

THE Lehigh Valley Car Works, at Stemton, Pa., are building 1,250 freight cars for the Central Railroad of New Jersey.

THE car works of Pennock Brothers, at Minerva, O., are building a number of coal cars for the Cleveland & Canton road.

THE Brooks Locomotive Works are building 20 ten-wheel locomotives with 18 × 24-in. cylinders for the Atchison, Topeka & Santa Fé Railroad.

AMONG recent orders placed with the Baldwin Locomotive Works, in Philadelphia, are 50 freight engines for the Missouri Pacific and 25 for the Norfolk & Western Railroad. It is stated that 5 of the Norfolk & Western engines are to be Vauclain four-cylinder compounds, and these engines are to receive a careful test in the service of that road.

THE Schenectady Locomotive Works are building a new foundry 100 × 346 ft. in size. The building is of iron, and will be put up by the Phenix Iron Company. The foundry will have three cupolas, and will be provided with a 15-ton Sellers traveling crane with an electric motor, and three 10 ton jib cranes. The building occupied for a foundry at present will be added to the machine shop as soon as the new foundry is finished. It is stated that these works now have contracts for 35 two-cylinder compound engines with the Pitkin valve, intended for different roads.

THE Berlin Iron Bridge Company, East Berlin, Conn., is building a new machine shop for the Worthington Hydraulic Works, in South Brooklyn, N. Y. The building is 200 × 50 ft., and will have a Sellers traveling crane, which will run the whole length of the shop.

THE Long Island Railroad Company has ordered from the Baldwin Works 10 Forney engines for suburban business. These engines will have four cylinders of the Vauclain type, 9 in. and 15 in. in diameter by 20 in. stroke. The driving-wheels will be 51 in. in diameter. The weight in working order will be 60,000 lbs., of which about 42,000 lbs. will be carried on the driving-wheels. The boilers will be 44 in. in diameter, and will be built for a working pressure of 180 lbs.

THE Robert Poole & Sons Company, of Baltimore, is engaged in some important contracts, and the shops are very busy. The Company is furnishing the plant for the extension of the Washington & Georgetown cable road; also that for the extension for the Baltimore Traction Company's cable line. The shops recently turned out some very large gearing for the

Detroit Brass & Copper Works, and are doing some work for the turrets of the new battle-ship *Texas*.

The shops of Bement, Miles & Company, in Philadelphia, have recently completed a very large vertical and horizontal planing machine for the Newport News Ship Building Company. In this machine the cutting tools have a vertical movement of 21 ft. and a horizontal movement of 23 ft. It is intended for planing steel plates, and occupies a floor space of 30 × 40 ft., and is 33 ft. high from the ground to the apex. The same firm recently built for the Newport News Company a lathe which will swing 10 ft. 6 in. in diameter and 40 ft. between centers. This tool is to be used for turning large shafts and cranks. They are also building a set of rolls for the same yard, which will be capable of bending plates 32 ft. long and 1¼ in. thick.

The Gould Coupler Company has had plans prepared for new and extensive shops at the new town of Depew, near Buffalo. The Company intends to have one of the largest malleable iron plants in existence. The foundry will be 660 ft. × 82 ft.; the annealing room 520 × 82 ft., and there will be a number of smaller buildings, including pattern shop, machine shop, engine room, etc. The buildings will be of brick with slate roofs. The Company has secured about 50 acres of land.

The Union Iron Works, San Francisco, recently launched a light-ship with steel frames planked with Oregon pine, sheathed with oak, and coppered. She is 112 ft. long, 27 ft. 8 in. beam, and 12 ft. 8 in. in depth, and is very strongly built.

The Cooke Locomotive Works, Paterson, N. J., have received a large order for new locomotives for the Louisville & Nashville Railroad.

The Pittsburgh Locomotive Works have recently built a number of engines for the Manhattan Elevated in New York. They are building several heavy passenger engines for the Pittsburgh & Lake Erie Railroad.

The Safety Car Heating & Lighting Company has recently equipped with its heating systems 50 cars on the New York, Lake Erie & Western; 20 on the Central Railroad of New Jersey, and 25 for the Wagner Palace Car Company.

The Dickson Manufacturing Company, Scranton, Pa., is building 4 consolidation engines for the New York, Ontario & Western, and 8 for the Delaware, Lackawanna & Western Railroad.

The Rhode Island Locomotive Works, in Providence, R. I., are building 27 passenger and 7 freight engines for the Boston & Albany, and 13 passenger engines for the New York, New Haven & Hartford. They have also orders on hand for the Wabash and the Union Pacific.

The first large steamer built by the Newport News Ship Building Company was launched from that Company's yard March 16. The ship is built for the Southern Pacific Company, and is named *El Sud*. She is an iron ship, 380 ft. long at the water-line, 406 ft. over all, 48 ft. beam, and 39 ft. depth of hold. She has a single propeller driven by a vertical triple-expansion engine, with cylinders 32 in., 52 in., and 84 in. in diameter and 54 in. stroke, and furnished with steam by three double-ended cylindrical boilers, each having six corrugated furnaces.

The William Cramp & Sons Ship & Engine Building Company in Philadelphia, is adding to its works the necessary tools for assembling and finishing guns up to and including 5 in. caliber. Projectiles will also be manufactured.

The Union Iron Works, San Francisco, are building a new steamer for the Pacific Mail Steamship Company. This vessel is 345 ft. long over all, 45 ft. beam, and 27½ ft. depth of hold. She will have a triple-expansion engine and six steel boilers, each 12 ft. in diameter and 11½ ft. long, built for 160 lbs. working pressure.

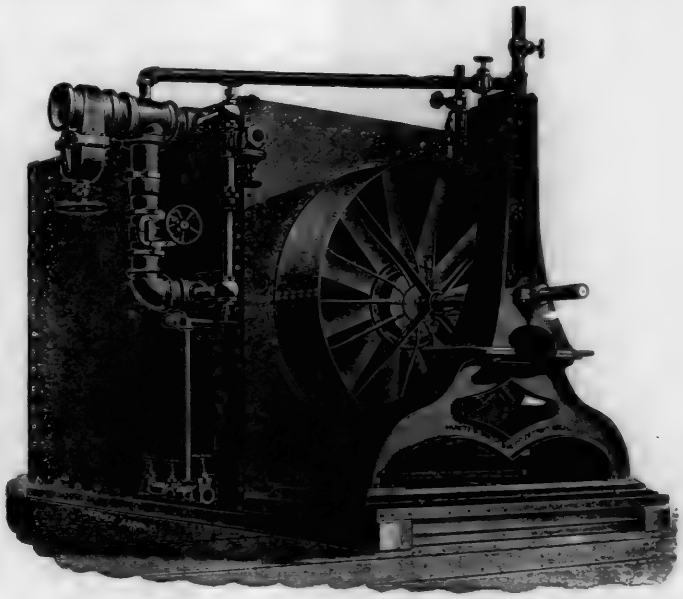
The Erie Car Works, Erie, Pa., are at work on orders for 500 hopper-bottom gondolas and 600 box cars.

The Harrisburg (Pa.) Foundry & Machine Company has just closed a contract to equip the new power station of the Wilkesbarre & Wyoming Valley Traction Company, at Wilkesbarre, Pa., with an entire outfit of engines, boilers, etc.

The Pittsburgh Locomotive Works have begun the erection of a new machine shop. It will be built of brick, with iron framework, and will be 365 × 125 ft. They are also building a blacksmith shop, 365 × 100 ft., with an 80-ft. wing, which will be used for a hammer shop.

The Harlan & Hollingsworth Company, Wilmington, Del., is building 25 passenger cars for the Illinois Central Railroad.

The Huyett & Smith Manufacturing Company, of Detroit, recently put one of their hot-blast apparatus into the Chicago & Grand Trunk shops at Fort Gratiot, Mich. The apparatus



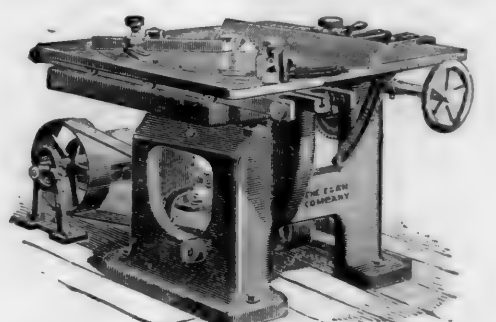
THE SMITH HOT-BLAST APPARATUS.

used has a 72-in. fan, and is capable of delivering 60,000 cub. ft. of air per minute; the fan is run by a vertical high-speed engine directly attached. The main shop is 90 × 400 ft., and the heated air is forced directly into one end of the room. The plan has proved an entire success. In this case no pipes are used to distribute the air, thus saving a considerable expense.

A New Saw.

The accompanying cut shows a new double rip and cross-cut saw, designed for edging, ripping, and cross-cutting, and especially intended for pattern making and other close and accurate work. The tool can be quickly changed to suit the work wanted, and it is very simple in construction.

The column is one entire casting, with the saw mandrel arranged to revolve around a common center inside the column, so that when the ripping saw is above the table, the cut-off saw



IMPROVED DOUBLE-RIP AND CROSS-CUT SAW.

is below the table, and for grooving, either saw can be brought above the table according to the depth of groove to be cut.

The table is of iron, made in two sections, both sections planed perfectly true, and the one at the left of the saw made to work back and forth on rollers, for edging or cross-cutting. There are two miter fences for cutting right and left, and one ripping fence, all accurately fitted to the table and in line with the saw.

The mandrels are of the best quality of steel, running in self-oiling boxes lined with Babbitt, and driven from a countershaft placed clear of the column, a decided improvement.

This is a very useful and convenient tool. It has been designed and built by the Egan Company, Nos. 194–214 West Front Street, Cincinnati.

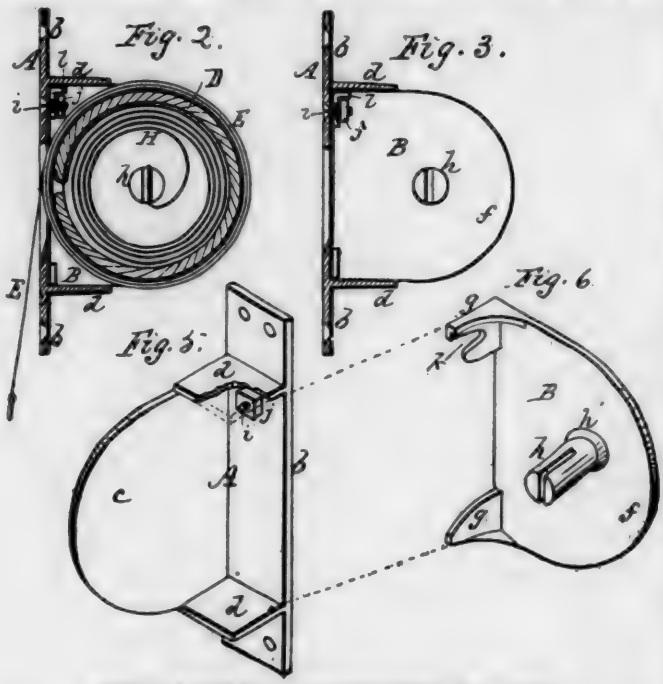
The Caldwell Car-Window Balance.

Most travelers are well aware, by painful experience, that the old-fashioned car window is a troublesome and very imperfect device, to which are due much annoyance and a frightful amount of profanity. An arrangement which will permit the

Fig. 1.

sash to move up and down freely, and will hold it at any point desired, will be thoroughly appreciated by the wayfarer and will prevent much unreportable language.

The accompanying illustrations show a device which, it is claimed, will do this; and the claim is supported by several years' successful use. Fig. 1 is a perspective view of this bal-



THE CALDWELL CAR-WINDOW BALANCE.

ance; fig. 2 is a section; fig. 3 shows the case with the spring removed; figs. 5 and 6 show the details of the case.

In this device a coiled steel clock spring sustains the weight of the sash, giving a steady and noiseless motion, while the working is more even and smooth than that of a weighted sash. The spring is connected to the sash by a ribbon of aluminum-bronze, of great strength and durability, as this alloy does not corrode. The balance only requires a plain frame, without boxes or pockets. A set-screw in the face plate serves to adjust the balance for a variation in the weight of the sash. The construction is simple, and will be readily understood from the drawings.

This balance is made by the Caldwell Manufacturing Company, of Rochester, N. Y., and is in daily successful use.

Strength of Cast Iron.

The iron made in the old charcoal furnaces of the Salisbury District in Northwestern Connecticut has for many years been noted for its strength. The Landon Iron Company, which owns the furnace at Chapinville, Conn., has recently been making experiments with a view of still further improving the quality. One step taken has been to calcine the ore in kilns before its reduction in the blast furnace. A number of tests made of pig iron from this calcined ore have given a tensile strength of from 34,761 to 41,882 lbs. per square inch, the samples being broken in a Riehle Brothers testing machine. This iron is sharp grained, and in casting wheels gives a hard and dense chill, while the plates are more elastic than when the iron is made from uncalcined ore.

An Automatic Numbering Machine.

The small illustration given herewith shows an exceedingly convenient automatic numbering machine, which is made by the Bates Manufacturing Company, of New York, and which can be used for a number of purposes, such as numbering railroad tickets, documents, or for any other purpose where consecutive numbering is desired. The machine is very small and light, weighing only about 14 oz.; works quickly and with but little friction, and yet is strong and able to stand a large amount of work. It is automatic in its operation, and requires no further attention than to set the indicator dial in the front at the proper point. As shown by the face in the engraving, it can be arranged to number consecutively, to number in duplicate or to repeat the same number, in all cases working automatically and without attention. Durability is secured by making the ratchets solid in each disk. They are milled upon their inner edges, and therefore present a wearing surface equal to the width of the wheel.

THE BATES AUTOMATIC NUMBERING MACHINE.

The inking attachment is convenient, and does not require frequent renewal. The machine has a gauge-plate by which accurate alignment can be secured.

It is made in different sizes with from 4 to 7 wheels. The largest size numbers consecutively from 1 to 9,999,999. When numbers in series are required, letters instead of figures can be engraved upon the last wheel, and so arranged as to change automatically when the numerical limit of the machine is reached. It is made with different sizes and styles of figures, and has the advantage of being lower in price than any machine of the kind yet placed in the market.

Some use of this machine upon the editorial desk shows that the claims of the manufacturers are well founded as to its convenience, handiness, and certainty of action.

Standard Couplers.

The Committee—Messrs. John S. Lentz, J. M. Wallis, and G. W. Rhodes—appointed by the Master Car-Builders' Association, have considered it desirable to issue the following circular to all manufacturers of vertical-plane couplers for the purpose of securing uniformity in M. C. B. standards, and to determine a standard of excellence in material and design.

"For the accurate determination of the contour lines, the gauges now made by the Pratt & Whitney Company will be used. These gauges have been determined by the Executive Committee; in pursuance of the action of the Convention and the instructions transmitted by the Convention to the Committee, the standards of length, thickness, and other dimensions adopted by the M. C. B. Association, and illustrated in the announcement from the Executive Committee under date of August 1, 1891, must be strictly conformed to. The Committee further recommends the pocket or U-shaped fastening in lieu of the tail-bolt. The Committee further proposes the following specifications for the M. C. B. draw-bars:

"1. Weight. Draw-bars, including knuckles and locking attachments, should weigh 210 lbs. or less; they must not weigh over 220 lbs.

"2. All drop tests will be made on a solid masonry foundation. The knuckle of the bar to be tested will be in its closed locked position. The bottom of the drop will be flat so as to represent the blow from an opposing closed M. C. B. bar.

"3. Pulling test. Draw-bars must be constructed so that when subjected to a pulling test, they will stand not less than 100,000 lbs. In view of the rebound draft rigging is subjected to after an emergency application of brakes, the Committee will consider increasing this limit to 110,000 lbs.

"4. Drop test. Draw-bars should stand the following drop test: Weight of drop, 1,640 lbs.; 3 b'ows at 10 ft.; 2 blows at 15 ft. The draw-bar or knuckle must break into two or more pieces before it is considered to have failed under this test. The cracking of the parts will not be considered as a failure.

"5. In subjecting bars to tests 3 and 4, the draw-bars and knuckles will be considered separately—that is, a failure of one will not condemn the other.

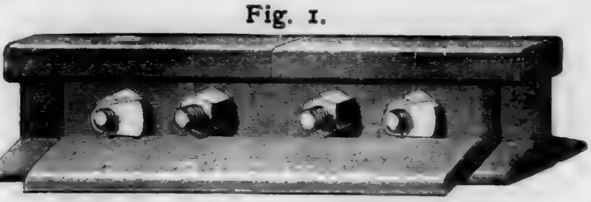
"These specifications are not supposed to be entirely accurate, but they are offered by the Committee as a step in the direction of adopting specifications which will make a standard of excellence in M. C. B. couplers."

The Young Reversible Nut-Lock.

The drawings given herewith show a new type of nut-lock devised by Mr. Levi H. Young, of the St. John Bolt & Nut Company, at St. John, N. B. Fig. 1 shows a rail-joint with these nut-locks; fig. 2 is a view of a track-bolt with the lock attached, and fig. 3 is a separate view of the lock itself.

This nut-lock is based upon the principle that an outside lock, which will tend naturally to tighten itself continually, is the true form, especially for a rail-joint. The spring lock placed under the bolt, it is claimed, has a contrary tendency, and whatever force may be exerted by its spring will be added to the other forces which tend constantly to work the nut loose

Fig. 1.



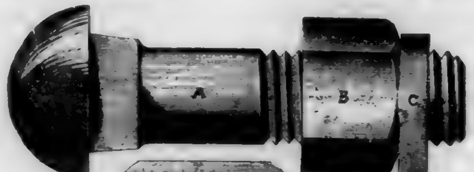


Fig. 2.

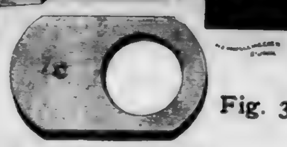


Fig. 3.

THE YOUNG PATENT NUT-LOCK.

and to injure the thread. The Young lock is so arranged that the force of gravity will continually tend to tighten it up, as the constant jarring and movement of the rail is felt. The lock being left in the position shown in fig. 1, the force of gravity would act to throw the heavy end downward—that is, to screw it up tighter and tighter. This claim seems to be well founded, as will readily be seen from an examination of the device. The lock is made of a thickness equal to $3\frac{1}{2}$ or $4\frac{1}{2}$ times the pitch of the thread, so that when screwed up on the bolt it can always be made to come into the position in which the advantage gained by gravity will come into play. If, when screwed up on the bolt, it should come into the position in which it would tend to turn off instead of on, it is simply necessary to take it off and reverse it, changing the position of the heavy side 180°. It can be app'ied to any rail-joint, with bolts having the usual standard thread, without removing the nuts, and, as can be seen from its construction, it can be made as cheaply in large quantities as any ordinary nut-lock.

It may be said, in effect, that this lock is an ordinary jam-nut with the addition of the extra weight, which not only prevents it from turning backward, but operates continually to turn it up and take up any slack which may result from wear.

This nut-lock has been subjected for some time to the test of actual use. About 150,000 have been in use on the Intercolonial Railway for over a year, and the Chief Engineer of that road, Mr. Collingwood Schreiber, states that it is serving its purpose very satisfactorily, and that he regards it as one of the best nut-locks ever brought to his notice. It has also been in use with very satisfactory results on the Canada Atlantic, the Nova Scotia Central, the New Brunswick Railroad, and on the Canadian Pacific in the Montreal yards. In the latter position the Yardmaster stated that a number of different devices have been tried, but that all required constant attention until this was introduced. It has also been in use on the Central Vermont and on the New York & New England experimentally with equally favorable results. It is now on trial on the New York Central & Hudson River Railroad and the Manhattan Elevated. On the former line it has been placed where there is an exceedingly heavy traffic, and the Supervisor in charge of the Grand Central Yard reports very strongly in its favor.

There seems to be no doubt that this is an excellent device, and it is especially well adapted to use on a rail-joint.

PERSONALS.

Colonel Thomas Cogswell has been appointed Railroad Commissioner of New Hampshire.

George H. Coryell has resigned his position with the West Virginia Central & Pittsburgh Railroad, and has opened an office as Consulting Engineer in Washington.

Jacob W. Miller, formerly General Manager of the New York, Providence & Boston Railroad, has been elected Second Vice-President of the New York, New Haven & Hartford Company.

William Kirkby, of Toledo, has been appointed Railroad Commissioner of Ohio. He was at one time a conductor, and later Yardmaster on the Lake Shore & Michigan Southern Railroad.

James E. Greensmith has been appointed General Manager of the Portland Company at Portland, Me. Mr. Greensmith was recently with the Pond Machine Works, but was formerly for a number of years with the late William Mason at Taunton.

William Voss, recently Master Car Builder of the Burlington, Cedar Rapids & Northern Railroad, has been appointed Superintendent of the works of the Barney & Smith Manufacturing Company at Dayton, O.

Alexander Mitchell has been appointed Superintendent of Motive Power and Equipment for the Eastern and Northern Divisions of the Philadelphia & Reading Lines. These divisions include the Lehigh Valley Railroad, upon which Mr. Mitchell has served for some years as Master Mechanic.

Timothy Hopkins has resigned his position as Treasurer of the Southern Pacific Company. Mr. Hopkins has presented his large library of books on railroad topics to the Stanford University, accompanying this gift with another of a large sum of money for the purpose of making a complete library, which shall include, if possible, all the books on railroads ever published.

OBITUARY.

Ario Pardee died suddenly at Rock Ledge, Fla., March 26, aged 81 years. He was born in Nassau, N. Y., studied engineering, and at an early age became engaged with the late Judge Asa Packer. Under his direction Mr. Pardee was engaged for a number of years in surveys for railroads in the anthracite region in Pennsylvania. The Beaver Meadow Railroad, now part of the Lehigh Valley, was built under his charge, and a number of short branches were located and constructed by him. He also laid out the town of Hazleton, Pa., about 1840. He was placed in charge of several coal mines near Hazleton, and he afterward invested largely in coal mines, gradually becoming a large owner and operator, and accumulating a great fortune. In addition to his coal mines, he was interested in the blast furnaces at Stanhope, N. J., the car shops at Watsontown, Pa., and some other manufacturing enterprises.

Mr. Pardee presented Lafayette College at Easton, Pa., with the hall bearing his name—a building erected at a cost of $350,000—and subsequently rebuilt it when it was damaged by fire. It is understood that he has left a considerable sum of money to the same college.

Major H. Wadsworth Clarke, who died in Syracuse, N. Y., February 26, aged 54 years, was born in Harford, Pa., but at an early age removed to New York State. He received a careful training as an engineer, and when still a young man entered the office of the City Surveyor of Syracuse, and served there as assistant until 1861, when he entered the Army, serving in a New York regiment, in which he rose to the rank of Captain. After the war he was appointed City Surveyor of Syracuse, and served as such for five years. After leaving that position, he continued to practise his profession, and from 1877–86 was in charge of the surveys of the State boundary-line between New York and Pennsylvania. In 1889 he again became City Engineer, but a year later was forced to resign by ill health, which prevented him from undertaking further work.

As an engineer Mr. Clarke held high rank. He was for a number of years a member of the American Society of Civil Engineers, and was also a prominent member of the American Meteorological Society. He was also Secretary of the Onondaga Historical Society and a prominent member of other local associations. He was naturally a very energetic man, and felt severely the long illness from which he suffered.

GENERAL GEORGE STARK, who died in Nashua, N. H., April 13, aged 69 years, was born in Manchester, N. H., and was a descendant of the famous General John Stark, of Bennington. He began work as a civil engineer at an early age, and was employed in the construction of the Nashua & Lowell, the Concord, the Boston, Concord & Montreal, and the Stony Brook roads, and in the surveys of the Vermont Central and portions of the Old Colony Railroad. In 1849 he was appointed Superintendent of the Nashua & Lowell, and three years later became Superintendent of the Hudson River Railroad. In 1857 he went back to the Nashua & Lowell, and afterward was appointed to the same position on the Boston & Lowell. When the two roads were practically united he operated them as Manager under the joint agreement, and continued in that position until the agreement was terminated. Subsequently he was one of the committee which reorganized the Northern Pacific after the failure of 1873, and for a time he was Vice President and General Manager of that road. For some years past he has retired from active work. General Stark was a prominent figure in railroad and political circles in New England for many years, and it was under his charge that the Boston & Lowell became one of the important Boston lines. He served several terms in the New Hampshire Legislature, and was a candidate for Governor of that State in 1861.

PROCEEDINGS OF SOCIETIES.

National Conference of Railroad Commissioners.—The fourth annual Conference of Railroad Commissioners met at the rooms of the Interstate Commerce Commission, in Washington, April 13. Commissioner E. P. Jarvey, of South Carolina, was chosen Chairman.

At the first session reports were presented by the Committees on Railroad Accounting and on Reasonable Rates. The latter recommended amendments to the Interstate Commerce Act providing for the trial of cases in Court on the evidence introduced before the Commission, in cases where appeals may be taken from the decisions of that body as to reasonable rates.

At the afternoon session the Committee on Use of Private Cars reported, recommending the restriction of mileage on private cars to a reasonable payment for their use when loaded; no mileage to be allowed for returning empty cars, and no discrimination to be made against shippers of any class of freight who do not furnish their own cars, railroad companies to be required to furnish them with cars as needed.

On the second day the reports of the Committees on Legislation and on Safety Appliances were read and discussed. There was also a long discussion of the report on Uniform Accounts, read on the first day. It was decided to advise Federal Legislation on Safety Appliances.

American Society of Civil Engineers.—At the regular meeting in New York, April 6, a paper was read by Mr. Willard Beahan on the Main Intercepting Sewer in Brooklyn, special explanations and diagrams being presented. The paper included a consideration of the methods of tunneling in general use, and a description of the pilot system adopted in the work described. A written discussion by Mr. A. F. Sears was read, and there was a verbal discussion by a number of the members present.

It was announced that the Directors had fixed upon the Hygeia Hotel, at Old Point Comfort, Va., as the place to hold the Annual Convention, which will begin on June 8.

The following elections were announced:

Members: E. H. Beckler, Helena, Mont.; Edward Mohun, Victoria, B. C.; S. Tomlinson, Bombay, India.

Associate Members: John S. Elliott, Jamaica, West Indies; William C. Hawley, Chicago, Ill.; Walter G. Kilpatrick, Nashville, Tenn.; Edwin Mitchell, Chambersburg, Va.; Walter F. Whittemore, Hoboken, N. J.

American Railroad Association.—The spring meeting was held in New York, April 13. The Secretary reported an increase in the membership of the Association.

The first business was the annual address of the President, Mr. H. S. Haines, which is referred to upon another page.

The Committee on Car Service made a report recommending the adoption for one year of a charge of one-half cent a mile, and six cents a day for the use of freight cars. This called out much discussion, and action upon the report was finally postponed to the next meeting.

The Committee on Train Rules reported that they had not received sufficient encouragement from correspondents to recommend any action on the adoption of the 24-hour system. A number of suggestions have been received on the Standard Code of Rules, but no report was made. It is proposed, however, to hold a special session of the Association in Chicago this summer, to be devoted to considering train rules and signals.

The Committee on Safety Appliances made a report on Power Brakes, substantially recommending that all new locomotives and cars built for freight service should be fitted with such brakes, and all locomotives with driver brakes. This Committee also reported that there are now about 135,000 freight cars in service fitted with the M. C. B. type of coupler, and about 27,000 more under construction, which will have the same coupler.

The following officers were elected: President, H. S. Haines; First Vice-President, Lucius Tuttle; Second Vice-President, E. B. Thomas; Members of Executive Committee, H. F. Royce and Joseph Ramsay, Jr.

American Society of Mechanical Engineers.—The members who join in the trip to the California meeting will leave New York on May 4 by special train, and will reach San Francisco May 16, stops being made at Niagara, Chicago, Manitou Springs, Cañon City, Salt Lake and Monterey.

The excursions after the meeting will include trips to Los Angeles and Southern California, to Oregon, and to Oregon, Washington and the Yellowstone Park.

A number of good papers are announced for the meeting.

Boston Society of Civil Engineers.—At the annual meeting, in Boston, March 16, the reports showed a total of 290 members, with the treasury in good condition.

The following officers were elected for the year: President, Henry Manley; Vice-President, A. F. Noyes; Secretary, S. E. Tinkham; Treasurer, E. W. Howe; Librarian, F. W. Hodgdon; Director, Frederick Brooks.

After the business had been disposed of, Mr. Thomas C. Clarke made an address on Progress in Bridge Building, with special reference to deep foundations and long spans. His remarks were illustrated with views of a number of notable bridges.

Western Railroad Club.—At the regular meeting, in Chicago, March 15, there was an extended discussion on Mr. Forsyth's paper on the Strength of M. C. B. Couplers.

The rest of the meeting was devoted to discussing amendments proposed to the Rules of Interchange. A number were reported by the Committee, and nearly all of them were approved after discussion. Among the amendments were a general revision of the rules concerning Brakes and Draw Bars; Changes in the Prices of Wheels, Axles and Couplers. The discussion was to be continued at the next meeting.

Central Railroad Club.—At the regular meeting in Buffalo, March 23, the Committee on Steel Trucks reported that these trucks have not been in use long enough to determine their weak points and their cost of maintenance, and recommended a further trial. This was discussed at some length.

A number of proposed amendments to the Rules of Interchange were discussed, but no final conclusion was reached. A committee was appointed to confer with the Superintendents' Association and discuss some means of facilitating movement of cars employed in local freight.

Engineers' Club of Philadelphia.—At the regular meeting, March 19, Mr. Arthur Falkenau presented a paper on the Cost of Power in Mexico, and in some Western mining regions. He referred to the high cost of fuel and other supplies, and said that in Mexico labor was so cheap and fuel so dear that there was little to be gained by introducing improved machinery.

Mr. Paul A. N. Winand read a paper on the Cost of Power in Using Internal Combustion Engines. This was followed by a short discussion.

The Secretary read for Mr. Alan N. Lukens a paper on Cost of Errors in Transmission of Power, in which he cited numerous instances of erroneous transmission which had come under his observation. In summing up the evils of erroneous transmission, he said, there were to be noticed, first, the alignment of the shafting, the spacing of hangers and pulleys; second, the adjustment of the bearings, the size of the pulleys, and the tension of the belts. All these add to the power required, and

therefore cost money, as well as requiring extra time and labor, to keep them in anything like good order, and time is money, as every one knows.

This paper was discussed at some length.

At the regular meeting, April 2, the following members were elected: Henrik V. Loss, F. V. Hetzel, Clayton W. Pike, H. M. Montgomery, C. O. C. Billberg and Charles W. Close.

Mr. W. S. Auchincloss read a paper on Yearly Tides.

In this paper the author stated that he proposed to show that confined bodies of fresh water are subject to yearly tides of greater or less magnitude, depending upon the nature of the basin or upon the strata to which they are confined, and upon the effect of evaporation if in an open basin. This was generally discussed.

Mr. Jacques W. Redway presented a paper on The Influence of Rainfall on Commercial Development, a study of the arid region, including some accounts of methods of irrigation.

The Secretary presented for Mr. George A. Bullock a large wall map, showing the street-paving of Philadelphia, which was accepted with thanks.

Mr. Mordecai's Note on Engineering Civil Service was presented by the Secretary, together with a letter giving the information relating to that portion of Ireland referred to.

The Secretary also presented from Mr. Robert A. Cummings a letter on the same subject, explaining the method of determining the necessity and placing the contracts for any work which may be desired.

Civil Engineers' Club of Cleveland.—The April meeting of the Club was held in the club rooms, April 12. Ernest C. Barth and Peter Rasch were elected active members.

The paper of the evening was read by Dr. Dayton C. Miller, of the Case School of Applied Science, on Astronomical Spectroscopy. The general theory of spectrum analysis was given, the sun being considered the typical source of energy. The spectroscope in its different forms was described, and its application to the study of solar phenomena explained. Special attention was given to a description of the new universal spectroscope recently made by Brashear for Professor Young, of Halsted Observatory of Princeton College. This instrument is more complete and perfect than any before constructed; it is adapted for either visual or photographic work on the sun, stars and comets. Professor Young has already made some excellent photographs of the spectrum of sun spots, the chromosphere and prominences, fixed stars and planets, which promise brilliant results. Solar investigations at Princeton are to be continued and the work extended to the study of stellar motion in the line of sight. Mention was made of the very valuable work of Professor George E. Hale, of Chicago, and Professor Vogel, of Potsdam. The paper was illustrated with lantern slides, many being from original negatives of recent date.

Engineers' Society of Western Pennsylvania.—At the regular meeting, April 19, Mr. George S. Davison read a paper on Discharge Observations on Large Streams, which was afterward discussed by members present.

A number of chemists of Pittsburgh and vicinity have become members of the Society, and a Chemical Section has been formed which holds regular meetings.

Engineers' Club of St. Louis.—At the regular meeting, March 16, Chancellor W. S. Chaplin was elected a member.

Mr. Arthur Winslow read a paper on the Progress of Mapping in Missouri, in which he sketched the history of map making, referring at some length to the early maps. More recently the United States Coast Survey began, in 1871, with a triangulation across the State, and in 1882 precise leveling was carried across the State. The Mississippi and Missouri River Commissions had carried the work along those rivers; and the United States Geological Survey from 1884–89 mapped about one-third of the State, chiefly in the central part. The State Geological Survey is at present engaged in mapping the State. A discussion by members present followed the reading of this paper.

At the regular meeting, April 6, A. A. Stuart, C. B. White and T. L. Condran were elected members.

The organization of an association for the Abatement of the Smoke Nuisance was referred to.

Mr. E. A. Hermann then read the paper of the evening, on Steam Shovels and Steam Shovel Work. The steam shovel is not a very old machine; its general use dates from about 1875. The steam shovel for railroad use only differs from those for general work merely in being mounted on standard gauge trucks. The machinery of a steam shovel works either through positive gearing or through friction clutches. The latter works more rapidly and is better adapted to softer materials, but heats the clutches easily, often causing delays. The positive gearing machines are a little slower but more reliable, especially for hard material. The sketches showed manner of making cuts of different depths and widths; also showed the plow and spreader, and manner of using them, for unloading and distributing the material loaded on cars by steam shovels.

Discussion followed by Messrs. Crosby, Hermann, Ockerson and Wheeler.

Mr. Perkins described an instance of the delivery pipe from a boiler becoming choked with scale. Colonel Meier cited an instance where the intrainment was 14 per cent.

A discussion on the purification of the city water was taken part in by Messrs. Seddon, Potter and Johnson.

Professor Johnson exhibited the first scientific book on the truss bridge, entitled "Bridge Building," by S. Whipple, published in 1847.

Engineers' Society of St. Paul.—At the regular meeting, April 4, Mr. R. Davenport read a paper on the Red River of the North. This river is a ditch in the prairie, meandering on an average two miles to make one, with a discharge varying from 250 to 20,000 cub. ft. per second at Breckenridge, and from 600 to 50,000 at Pembina. The first work of improvement was begun in 1877; it was estimated to cost about $300,000, and was intended to make the river navigable for flat-bottomed craft by dredging and the removal of bank obstacles from Breckenridge to the Canada line, about 200 miles. On this $240,000 have already been expended. The banks are subject to slides peculiar to this river, banks of earth having a tendency to work themselves into the river at the level of its bed in the form of wedges extending horizontally some distance from the bank. The movements of these masses allows the surface above to settle undisturbed. The traffic on the river is wholly local, and seems to have varied with the precipitation. From 1879–82 it increased from 18,000 to 32,000 tons, then fell off to 1,700 tons in 1890, but last season again grew to 12,000 tons. The engineers' estimate is that the expenditure of $350,000 on reservoirs would make the river navigable all the year, excepting in the frozen season, while with $550,000 expended in locks, dams, and canals, the length of navigable tributaries might be doubled.

NOTES AND NEWS.

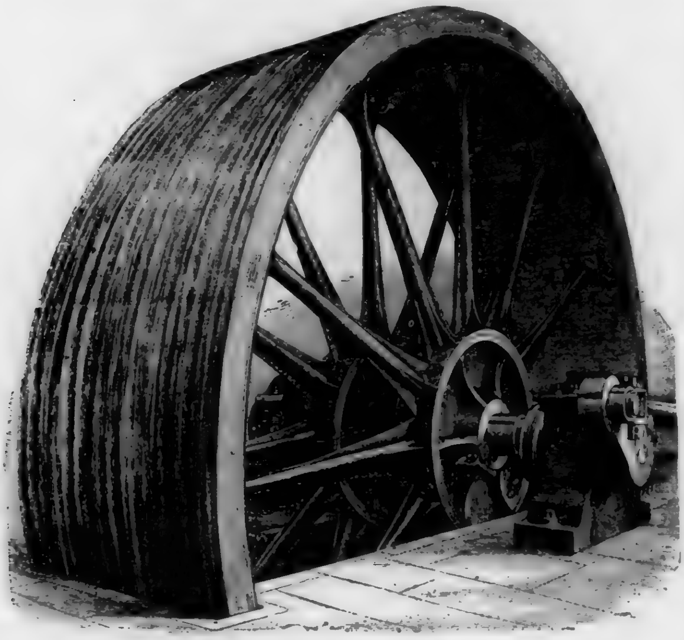
Compressed Air for Cleaning.—Compressed air for cleaning cars is used on the Union Pacific Railroad at its Portland shops. The air, under a pressure of 50 lbs. per sq. in., is delivered from a flexible hose with a small nozzle, and is used as water would be.—*Exchange.*

Earth Roads and Wagon Tires.—In an article in *Good Roads*, which ought to be read everywhere, Mr. Isaac B. Potter says: "The great destroyers of the common earth roads are water and narrow wheel tires. In the first place, those roads are, as a rule, wretchedly drained, or, in many cases, not drained at all. If a deep side ditch could be maintained on each side of the ordinary dirt road, and kept clear so as to receive and carry off the running water, the quality of the road would be improved, in most cases 100 per cent. This is a point which farmers seem to meagerly understand, or, at all events, one which they rarely put to practical use. Water has no place in any road, good or bad. It is more hurtful than any other agent of destruction. It should be carried off and out of every road as soon as it falls, if possible. Now, as to wheel tires, let me remind you that you said a little while ago that a road was good enough for your purpose whenever the mud would roll and pack under the wheel; and by this I understand that you look upon your wheel as a roller. So it is. Every road becomes smooth by the application of a roller, and this smoothing process is hastened or retarded by the quality of the roller itself. If you have a wheel tire 1½ in. wide, like those upon your farm wagon, every time you go down the road with a ton of produce, your wagon wheels sink into the soft mud, form ruts, and tend to keep the road in a rough condition. Your 1½ 'roller' will not profitably exert its rolling qualities until the mud becomes nearly dry. A wider wheel tire would serve your purpose much better; and if the farmers of your county would use wheel tires 3 or 4 in. wide, as are used abroad, your dirt road would be rolled into passable condition in half the time that is now required to accomplish this result.

"Next to water, nothing is so destructive of a good road surface as a heavy vehicle running on narrow wheels. It has been proven over and over again that wheels with 4½ in. tires cause only one-half the wear on the road that results from the use of

wheels with 2½-in. tires. It used to be the rule in England to make the tire 1 in. wide for every 500 lbs. of load or vehicle—that is, if the vehicle and load weighed two tons, 4-in. tires would be used; but it was not found profitable to increase the width much beyond 4½ in., except in cases where wagons were used without springs, when they were sometimes made as much as 6 in. in width."

A Large Wooden Wheel.—Our readers will recall the bursting of the 30-ft. fly wheel at the Amoskeag Mills, Manchester, N. H., last fall, full accounts of which were published at the



A LARGE FLY-WHEEL WITH WOODEN RIM.

time. This wheel has been replaced by the one we here illustrate, which is probably the largest wooden-rimmed wheel in the world. It was designed by the superintendent of the mills, Charles H. Manning, and was built in their own shops. This wheel is 30 ft. in diameter, 108½ in. face, 12 in. thickness of rim, and weighs 104,000 lbs. There are two sets of iron hubs and arms, each hub being made in two parts, 7½ ft. in diameter, 28 in. in length, and 20 in. face. The arms, of which there are 12 in each set, are circular in section, 8½ in. in diameter at the large end and 6 in. at the small end, and are formed with projecting webs, as shown. At their outer ends are plates 20 × 24 in., which are bolted to the rim by eight bolts 1 in. in diameter. Each arm is secured to the hub by four bolts 1½ in. in diameter. The rim is made up of 44 rings of Western ash, each ring being in 12 sections, each of which is secured by 16 lag screws. Between each set of arms there are four ¾-in. bolts extending through the rim from side to side. The cranks and connecting rods are balanced by plugs placed in the ends of the hollow spokes opposite the cranks. This work was done so well that the wheel has been run up to a speed of 76 revolutions per minute without showing the least indication of distortion. To form the rim, 20,000 ft. of ash were used, and 18,000 4 × $\frac{7}{16}$ in. lag screws. The segments are attached to each other with glue and lag screws and by the through bolts. As a further precaution, narrow openings were left between the ends of the segments, into which were driven well-fitted wedges soaked in boiling glue. In building the wheel, the first hub and its arms were put in place, revolved, and a score mark made on the ends of the arms. In line with this score the 12 sections of ash were bolted, the joints breaking over the ends of the arms. The next ring of ash was glued and lag-screwed to this. This was continued until the other set of arms was reached. Each ring was finished before starting the next. The whole pulley was turned while in place. The wheel is driven by engines having a diameter of cylinders of 36 in., stroke of 6 ft., and is intended to be run at a speed of 61 revolutions.

We may add that Mr. Manning is now building another fly-wheel having unusual features. The center and arms will be of cast iron, and the rim, 14 ft. in diameter, 30 in. face, and 12 in. thick, will be composed of 24-in. plates of ½-in. mild steel, riveted through and through.—*Iron Age.*

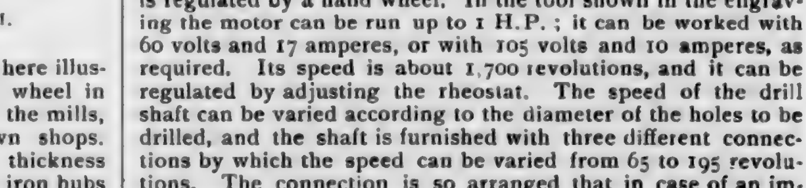
Steamship Companies of the World.—According to the statements of the French *Bureau Veritas*, the ten leading steamship companies of the world, arranged in the order of tonnage owned, are as follows:

	No. of Steamers.	Total Tonnage.	Average Tonnage.
1. Norddeutscher Lloyd	66	221,603	3,358
2. British India	91	199,096	2,188
3. Messageries Maritimes	62	192,631	3,107
4. Peninsular and Oriental	48	187,684	3,910
5. Cie Generale Transatlantique	64	165,635	2,588
6. Florio-Rubattino	105	161,687	1,540
7. Wilson Line	84	147 162	1,752
8. Hamburg-American Co	44	136,659	3,106
9. Allan Line	42	130,156	3,077
10. Austrian Lloyd	76	123,565	1,626

The same authority gives the total number of steamship companies of the world as 161, excluding those of merely local importance. The four leading nations, as far as the number of companies owned, are: England, 64; France, 33; United States, 15; Germany, 12.

A Portable Electric Drill.—The accompanying illustration shows a portable drill operated by an electric motor, built by the Allgemeine Elektricitats Werke, of Berlin. The drill is carried upon a small truck, on which also are placed the motor and rheostat. The connection with the dynamo from which the power is derived is by a flexible cable, which is attached to the motor, and which is shown coiled up upon the truck. The shaft of the drill is connected to the motor shaft by a universal joint, so that it can be operated at any angle. The feed is regulated by a hand wheel. In the tool shown in the engraving the motor can be run up to 1 H.P.; it can be worked with 60 volts and 17 amperes, or with 105 volts and 10 amperes, as required. Its speed is about 1,700 revolutions, and it can be regulated by adjusting the rheostat. The speed of the drill shaft can be varied according to the diameter of the holes to be drilled, and the shaft is furnished with three different connections by which the speed can be varied from 65 to 195 revolutions. The connection is so arranged that in case of an improper regulation of the feed, there would be no danger of breakage, as the connection is not rigid, but is made by a small counterweight which is seen above the machine.

With a length of about 30 ft. of cable considerable latitude of movement is permitted; and the drill can be taken to different parts of the work with very little trouble to the operator. Its



PORTABLE ELECTRIC DRILL.

total weight, including that of the cable, is about 350 lbs. Drills similar to this have been found very useful in locomotive shops and in shipyards, and a number have already been manufactured and put in use. It would seem, however, as if in many cases a portable stand furnished with handles for lifting would be more convenient than the carriage shown.

A New English Bridge.—The accompanying engraving, from *Industries*, shows a bridge recently erected for the South-eastern Railway, of England, by the Horsley Company, of Tipton. The bridge crosses the River Medway, and has been built with the view of connecting Chatham with the above-mentioned company's line. The viaduct runs parallel with that owned by the London, Chatham & Dover Company, and is 670 ft. long, with four spans ranging from 120 ft. to 170 ft. It carries two sets of rails, and has outside lattice girders. The most interesting feature of the work, however, is the arrangement of the

MEDWAY BRIDGE, SOUTHEASTERN RAILWAY OF ENGLAND.

cylinders for carrying the piers. These are of the twin-type, representing in plan the figure 8, projecting down below high-water level a distance of 60 ft., and bedding in solid chalk. The superintending engineer of the work—Mr. Francis Brady—in adopting this form of cylinders had in view the attainment of the maximum of strength with the minimum of material. The cylinders are of cast iron, 13 ft diameter and 1 in. thick, and filled in with cement concrete. The piers are 16 ft. wide, and are constructed of brickwork. The bridge has a clear headway above high water of 20 ft. 6 in. Its total cost was about $350,000.

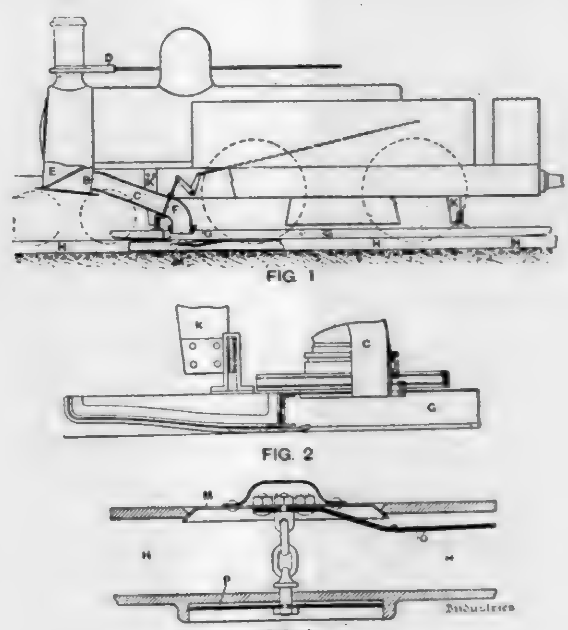
Merchant Ships of the World.—According to the tables of the French *Bureau Véritas*, the merchant shipping of the world includes 43 514 vessels, of which 33,876, with a tonnage of 10,540,051 tons, are sailing ships, and 9,638, of 12,825,709 tons, are steamers. The average tonnage of the sailing ships is, therefore, 311 tons; and of the steamers 1,331 tons. This, it must be understood, includes sea-going vessels only, boats and vessels engaged in inland navigation, whatever their size, not being counted.

The steamships of the different nations are as follows:

Country.	No.	Tonnage.	Country.	No.	Tonnage.
Great Britain.	5,312	8,043,872	Russia.	230	177,753
Germany...........	689	930,754	Denmark.	197	154,497
France........	471	805,983	Austria............	111	149,447
United States......	419	533,333	Japan	147	123,279
Spain....	350	423,627	Belgium	55	98,046
Sweden & Norway.	774	417,065	Brazil	129	75,970
Italy.	200	294,705	Greece	68	70,435
Holland...........	164	220,014	Portugal	41	49,364

It will be seen that, according to this statement, Great Britain owns 55 per cent. in number and 63 per cent. in tonnage of the steam merchant marine on the high seas. The ownership of the United States is 4½ per cent. of the total number and 4½ per cent. of the total tonnage.

Tunnel Ventilation.—The accompanying engraving, from *Industries*, shows a method of exhausting smoke from locomotives in tunnels, which has recently been patented in England by Mr. C. Anderson, of Leeds. The object of the invention is the purification of the atmosphere in underground railroads and tunnels by diverting the products of combustion given off from the locomotive, and carrying them through a communicating pipe to a flue in the permanent way. From this flue they are extracted in any suitable manner. Referring to the illustrations, fig. 1 shows a side elevation of a locomotive fitted with the necessary appliance; fig. 2 shows an enlarged section of the sliding-box fitted on the engine, and fig. 3 is a section of a portion of the flue in the permanent way showing a method of fitting the air valve. Briefly, the apparatus consists of a pipe, *C*, fitted into the lower end of the smoke-box, and having its lower end passing through a stuffing-box and fixed in the sliding-box *G*, which slides upon the suction flue *H* fixed between the rails. Dampers *D* and *F* are provided for opening and closing the funnel and the pipe *C* respectively, while a screen, *E*, is provided for preventing cinders from finding their way into the pipe *C*. The sliding-box *G*, of considerable length, is formed of sheet-metal and angle iron riveted together in such a manner that when it comes into contact with the air valves in the flue the valves will be opened without shock. The valves *M* in the flue are arranged at such a distance apart that there will always be one or two of them simultaneously held open by the action of the sliding-box *H*. To prevent damage to the apparatus arising from sudden shocks or oscillations, suitable brackets *K* and



PLAN FOR VENTILATING TUNNELS.

cross-bars are provided. The action of the valve *M* and slider *G* will be easily followed from figs. 2 and 3. The valve *M* is held up against its seat by a spring, *O*, until the slider comes into contact with and depresses it. After the latter has passed the valve again rises, but is prevented from rising too violently by an air-cushioning appliance, *P*, fitted below the flue. Other forms of air cushion and other joints for the flue can be used.

The Persian Wheel.—According to a writer of nearly a century back, this machine for raising water is composed of one

horizontal and two vertical wheels, the former turning upon a pivot, the spokes of which catch those of one of the vertical projecting through the fellies, and turn it round. From the nave of this last runs a beam about 8 ft. long, attaching itself to the second vertical wheel, which rests upon two beams placed across the diameter of the well, and working between them. To this second vertical wheel thick ropes are attached, upon which are tightly fastened a number of small earthen pots, like

PERSIAN IRRIGATION WHEEL.

the steps of a ladder, reaching on each side from the top of the wheel to the water. These pots successively dipping in are brought up full, and empty their contents into a trough on reaching the apex of the wheel. They thus produce a continued stream which is conveyed to the neighboring fields. Two bullocks, driven by a boy, passing under the beam which supports the machine, turn the horizontal wheel by a shaft to which the cattle are yoked. This method is said to be able to water four bigahs a day per machine.

The arrangement described, as might be expected, is extremely clumsy and inefficient, a large proportion of the power employed being wasted in overcoming the friction of the shaft in the ground.

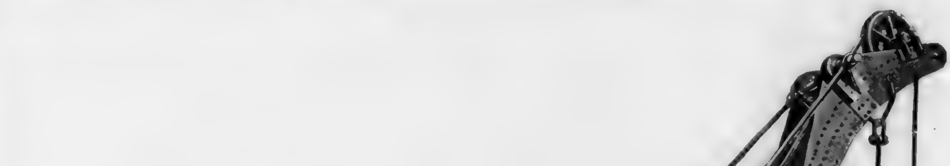
The usual number of earthen pots on these wheels is from 40 to 60 and they are generally placed quite close to each other, and as they are secured to the well ropes merely by a piece of string the breakage is comparatively great.

A vast improvement on this clumsy and primitive machine is the double or improved Persian wheel, which is an improvement introduced by English engineers on the primitive native machine, which, with the same labor of one man and two bullocks, gives almost exactly treble the result of the other.

The double or improved Persian wheel is generally employed in the military cantonments of the Upper Provinces for raising water for lavatories, swimming baths, and irrigation of the soldiers' gardens, and is admirably suited to the said purposes. The pity is that no one ever seems to have thought of providing the village cultivator with this greatly improved machine, and yet thousands of rupees are advanced yearly by collectors and deputy commissioners for the construction of wells.

Careful experiments, conducted at Roorkee some years ago, conclusively establish that for the irrigation of high lands, which are always to be encountered at heads of canals for distances varying from 12 to 30 miles to the head of irrigation, that is the level at which the canal water would flow on the natural surface, that the improved Persian wheel would be a cheap and efficient machine for irrigation of gardens, plantations, nurseries of young trees, and purposes of general cultivation.—*Indian Engineering.*

A Locomotive Steam Crane.—The engraving given herewith represents a general view of a 16-ton locomotive steam permanent way traveling crane constructed by Mr. T. Smith, of Rodley, near Leeds. The engines for operating the crane consist of a pair of the vertical type, with cylinders 8½ in. diameter and 12 in. stroke. These receive steam from a Nicholson type of boiler, 7 ft. 6 in. high and 4 ft. 6 in. diameter, with a large combustion chamber over the fire-box, and Galloway tubes. The jib is constructed on the lattice principle, with a curved head, to allow of heavy loads being dealt with. The crab sides are of mild steel plates, and are firmly secured to the top and bottom swivels. The latter have anti-friction rollers for running on a turned path to reduce the stress caused by the load on the central column. The hoisting motion is of double-purchase spur-gearing controlled by a clutch and lever, and powerful friction brake. A feed pump, injector, and tank are provided for supplying the feed water. The carriage is propelled by bevel wheels gearing with the engine shaft by means of spur and miter wheels, and driving the transverse shaft under the carriage, on which there are two cranks connected up by coupling rods and cranks to the traveling wheels of the crane. The frame of the latter is of mild steel plates and angles, and is mounted on six traveling wheels 3 ft. diameter, with cast-iron centers and steel tires shrunk and riveted on, and the axles are of steel. The whole superstructure radiates on a strong steel central pillar, accurately fitting a massive cast-iron base-plate,



A LOCOMOTIVE STEAM CRANE.

turned on the top to carry the roller path and internal wheel for revolving the crane. The various parts are easy of access for adjustment and similar purposes, and the whole of the movements are within easy reach and control of one attendant. The total weight of the crane is about 50 tons.—*Industries, London.*

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NEW YORK, JUNE, 1892.

THE New York rapid transit project is now in the hands of a commission appointed by the Supreme Court, which is examining into the objections made by property-owners. Legal processes are slow; and no one expects the underground project to go through for a long time to come.

THE Baltimore Belt Railroad is to try electrical locomotives for moving trains through its tunnels, and the Thomson-Houston Company is to furnish the plant, including motors of 500 H.P. The Belt road is a connecting line, a large part of which is underground, and the work over its tracks will be chiefly yard and transfer work.

THE waters of the Mississippi have been unusually high this year, and serious apprehension has been felt all along the lower river. Several crevasses in the levees have occurred and much emergency work has been required to prevent others. The waters were not falling at latest accounts, and cannot be expected to for some time, since high water and floods are reported on the Upper Mississippi and Missouri and their tributaries, and more damage is feared.

THE new road law of New Jersey, as amended this year, authorizes the county boards to contract for the building of macadamized roads, under certain regulations. The State will contribute one-third of the cost, up to an amount not exceeding $75,000 yearly. The building of macadamized roads is not altogether optional, the county board being compelled to act on petition of two-thirds of the property-owners on any road. The law was advocated by a large number of farmers and other owners of property.

THE next report of the Irrigation Division of the Department of Agriculture will show that some 9,000,000 acres of land are now under irrigation, and that arrangements have been made to take up a large additional area as soon as water supplies are provided for. A tendency to monopolize large tracts is indicated.

A BILL admitting foreign-built steamships to American registry has passed the House of Representatives. The conditions are somewhat stringent; the steamers must be of at least 8,000 tons register and capable of making 20 knots an hour; 90 per cent. of their value must be owned in the United States and the owners must have contracted for the construction of other vessels of equal tonnage and speed in this country.

The terms of this bill apply at present only to the steamers *City of New York* and *City of Paris* of the Inman Line, and these steamers will hereafter sail under the American flag. It is stated that the Inman Company will have two large steamers built—probably at the Cramp yards in Philadelphia—to add to the line, which are expected to be the largest and fastest ships in the Transatlantic trade. Similar bills have been introduced to give American registry to some steamers for the China line of the Pacific Mail Company.

THE biennial meeting of the International Railroad Congress is to be held this year in St. Petersburg, and the Executive Committee announces that the first session will be held August 20 next. The meeting will continue until September 3. There are some important questions to come up for discussion, and the programme for the meeting will soon be issued.

THE cruiser *Concord* was present at the ceremonies attending the opening of the Memphis Bridge, being the first vessel of the Navy to go so far up the Mississippi since the War. After the opening of the bridge the *Concord* kept on up the river to Cairo; it was at first intended that she should go to St. Louis, but it was thought that the high water in the river could not be depended on for so long a trip.

THE Naval Appropriation Bill, as it passed the House of Representatives, provided, as we have heretofore noted, for only one new ship, an armored cruiser of about 8,000 tons displacement, and of the same general type as the *New York*. The Senate has amended this bill by providing also for the building of one battle-ship of 9,000 tons displacement; one harbor defense ship of the double-turret Monitor type of 7,500 tons displacement; four light-draft gun-boats of from 800 to 1,200 tons and six torpedo boats. This amendment may or may not be accepted by the House, but the probability is that there will be a compromise and that several new ships will be authorized.

ON another page will be found a description of the located line of the Western Siberian Railroad, which will be the most important part of the great line which is to connect St. Petersburg with the Pacific. The account is based upon official information, and the writer has taken an active part in the survey and location of the line.

The Siberian Railroad is certainly the longest and perhaps the most important line now under construction in the world, and it is interesting to know that work upon it has been actually begun at both ends, with the definite intention of continuing it until the road is finished.

AN attack upon the Railroad Commissioners of New South Wales has been made in the Parliament of that colony by a Mr. Hoyle, the result being the appointment of a commission to investigate. One of the principal

charges made was in relation to the purchase of locomotives from the Baldwin Works, but the evidence taken seems, so far as we have received it, to show that these engines had done excellent work, hauling much heavier trains than the other engines could on the heavy grades of the mountain lines. One of the chief witnesses was Mr. D. H. Neale, now Mechanical Engineer to the Railroad Commission, who is well known in this country, and on whose advice the Baldwin engines were ordered.

THE transmission of power by electricity is attracting much attention among engineers, owing to the successful experiments at Frankfort and elsewhere. The possibility of utilizing many water powers which have hitherto been neglected because they were remote from any possible mill site is attractive. Now that room for a small power-house is all that is required, and the power generated can be carried anywhere where it is needed by a simple pole and wire line, there will probably be a demand for water powers which have heretofore been considered useless.

ENGLISH AND AMERICAN LOCOMOTIVES.

AFTER the last of our series of articles on this subject appeared in the JOURNAL for February, our English cotemporary, *The Engineer*, published answers to them, the first of which appeared in its issue of February 26. Those of our readers who have been interested in this discussion may remember that in the JOURNAL of last November we gave a table (II) showing locomotive performance and expenditures on over 40 different railroads in this country. In our December number we called attention to the fact that our American railroad companies do not all publish any statistics which show what their average train loads are. In the same issue of the JOURNAL those lines which do report the average number of cars hauled were selected, and the average weight of trains, fuel consumed per mile, and per ton per mile were tabulated (in table V). Twelve of our main lines, which include an aggregate mileage of over 16,000 miles of road, were included in this table. The average number of cars hauled per train on these lines was ascertained from accounts which are carefully kept for this purpose, and the figures were in no sense guesswork or approximated, but were based on the accounts and reports of the different companies. The average weight of passenger trains on the 12 roads was 130.3 tons (of 2,240 lbs.), exclusive of engine and tender. The average weight of freight train on all the roads was 553.5 tons. This, it was explained, was the average of the averages on the 12 roads; the maximum average load on any one of the roads was 816.5 tons, which was on the Philadelphia & Erie.

In its article of February 26 *The Engineer* attempts to discredit these figures, and says:

> Now it so happens that there are certain official or semi-official statistics published concerning American railways. How far these are or are not trustworthy we are unable to say. It will be seen, however, that they do not at all correspond with the figures given in the preceding table. The figures are contained in a report just issued by the Inter-State Commerce Commission for the year ending June 30, 1890. In it we find that the average number of passengers in a train was 41, and that the average weight of freight trains was 175 tons, with an average haul of 120 miles per ton. There is, it will be seen, an astounding and apparently irreconcilable difference between 175 tons and 553 tons.

The astonishment of our cotemporary would, perhaps, have been assuaged if he had observed that the train-load reported by the Inter-State Commerce Commission was the average for *all* the lines in the country, which is less than that on the 12 main lines included in our table, which all have a heavy traffic. Furthermore, it is certain that the data on which the Inter-State Commerce Commission figures are based are not reliable, for the reason that comparatively few of our companies keep the requisite accounts to supply correct statistics concerning train-loads, etc. They are all compelled to report to the Commission, but when they have not the requisite data at hand, they guess at them "to the best of their knowledge and belief."

But it is our turn to be "astounded" when we find that the figures quoted by *The Engineer* from the Inter-State Commerce Commission report do not represent what our cotemporary says they do, but something entirely different. On page 51, of the report quoted from, it is said, "the number *of tons of freight* carried one mile during the year covered by the report was 76,207,047,298. . . . Freight-train mileage during the period was 435,170,812, showing the averág enumber of *tons* (*of freight*) per train to have been 175.12." In other words, the figures quoted by *The Engineer* represent the *lading* alone and does not include the weight of cars in the train. In our table it was explicitly stated that the figures which our cotemporary tries to discredit represented the "weight of train, exclusive of engine and tender," on the 12 roads included in the table. That there should be a very great "difference" between this average weight on the roads named and that of the *lading alone* on all the roads in the country is not surprising, but that our critic should try to disprove the accuracy of statistics which were compiled from carefully kept accounts, by quoting figures which represented something totally different from what they did mean, is "astounding."

Our cotemporary admits that "there is considerable difficulty in obtaining full information concerning the weight of passenger trains in this country (England)," and also "in getting precise figures as to the loads carried" in goods trains. It is then said that "the regular passenger train on the Caledonian Railway consists of eight coaches, and the regular goods train consists of 40 wagons." Now it is not easy to know exactly what is meant by a "regular" train on the road referred to. The trains on that line are certainly not all of a uniform size, because the writer says that some passenger trains consist of 14 or 15 cars and some coal trains weigh 629 tons. If the figures are based upon statistics kept by the railway company, why not give its figures? If they are only more or less shrewd guesses at what the average train loads are on the line mentioned, then they are valueless as evidence. After a good deal of experience in collating such data, we have been convinced that the guess or mere mental estimate of what average train-loads are of even the most experienced railroad officials, is quite valueless as evidence of what is actually done on their own lines. There are a great many light trains on all roads, which are out of sight —that is, are running on branch lines to local points, and which, if accurately accounted for, will reduce the average weight of trains. The average weight and size of trains is nearly always less than a mere observer will suppose they are. In the absence of any statistics bearing upon the subject, we discredit entirely the estimate of *The Engineer* when it says that "we believe we are justified

in stating that the average weight of main line passenger trains in Great Britain cannot be much short of 120 tons." If it has no statistics its "belief" is only a guess, and only omniscience would be sure of being right in such a case.

The data in our table V include all trains run on the roads. In comparisons of locomotive performance, general averages must be compared with general averages, and special cases with others of a like kind. A general average must include everything and not be confined to some arbitrary portion of the locomotive performance on a line, or if the special performances of locomotives are compared, the conditions must be nearly enough alike to make the comparison a fair one. As an example of unfairness, reference may be made to *The Engineer's* quotation of the average consumption of fuel by all the passenger trains of the 12 roads included in our table V during a year, which was 66.97 lbs. per train mile, and the average weight of train exclusive of engine and tender was 130.3 tons. In comparison with this it cites the Great Northern engines, which, it says, with an average weight of train hauled of 177.6 tons and speeds of over 50 miles an hour, frequently exceeding 60 miles an hour, indeed for long stretches, the consumption was but 30.6 lbs. of coal per mile, or 0.172 lb. per ton per mile. These were the best engines on the Great Northern Railroad, running under conditions which attracted the attention of all England. Engines working under like conditions always do well. For a fair comparison with the data in our table *The Engineer* should give us the coal consumption and weight of trains hauled, by not only all the locomotives on the Great Northern Railroad—good, bad, and indifferent—but on a dozen of the main lines of Great Britain. Our cotemporary is comparing a race-horse with the average daily work of hundreds of hacks, many of them old and decrepit.

In commenting on the relative weight of English and American passenger trains our cotemporary says :

> Now one of the first points which the preceding table (our table V) proves is, that the American passenger train is by no means heavier than the English train, to anything like the extent alleged hitherto by the American technical press. It amounts to only 130 tons on the average.

He says, however, further that "there is considerable difficulty in obtaining full information concerning the weight of passenger trains in this country." The weight of "the regular passenger train" on the Caledonian Railway is then given at 125 tons. The weight of the *irregular* passenger trains, including local trains, those on branch lines, etc., are not given. Our table included *all* the passenger trains on the 12 roads named. The average weight of "main line passenger trains" on the Great Eastern Railway is given at 248 tons. Again, branch line and seemingly local trains are not included. It is said though that a deduction from this weight is admissible, and 235 tons is given as probably nearer the truth than 248. Apparently this estimate is mere guesswork, and is not based on any statistical data. This hypothesis is confirmed by the fact that in its following issue our cotemporary gives the weight of an average passenger train on the same road at 166 tons, a diminution of 69 tons in one week. On the Great Northern it is said to be 170 tons. On the London & South Western it is said some trains are run which weigh 321 tons. Our cotemporary summarizes its guesswork by saying, "We believe we are justified in stating that the average weight of main line passenger trains in Great Britain cannot be much short of 120 tons." Whether this includes the weight of engine and tender is not apparent. It certainly does not include trains on branch lines, and probably not local trains either. Is it fair to compare such an average guess with the results of carefully recorded statistics which were summarized in our table V, and in which were included *all* the passenger trains on more than 16,000 miles of railroad ?

It is possible, too, to show from published statistics that some of *The Engineer's* averages are unreliable. He gives the average number of passengers carried in the "regular passenger train" of the Caledonian Railway at 120 per train, and the weight of the train at 125 tons. Now in the *Railway Returns* for 1890, published in a Parliamentary blue-book, the number of miles traveled by passenger trains on this road is reported as 6,926,813, and the gross receipts from passenger traffic £988,921. Dividing the latter by the former gives 34¼*d*. as the average receipts per train-mile, and dividing this by 120, the average number of passengers carried, gives 0.285*d*., or 0.57 ct. as the average receipt per passenger per mile. Now, does the writer in *The Engineer* seriously believe that the Caledonian Railway Company carried all its passengers for a whole year at that average rate ?

Another deduction is possible from the *Railway Returns*. In 1890 the number of miles traveled by passenger trains in Great Britain was 158,214,555 miles, and the gross receipts from passenger traffic were £27,961,645. Dividing the one by the other gives 42.4*d*. as the receipts per mile, and dividing this by 120, the average weight of trains, will give a trifle over 0.7 ct. as the amount received for hauling passenger trains per ton per mile. If this really represents the cost of that service, it may be a question whether it would not be advisable to carry goods and coal in passenger trains on British roads.

But taking *The Engineer's* figures for the weight of passenger trains and the average English consumption of coal per passenger train-mile, which, it is said, "is certainly not over 36 lbs. a mile," and we have a consumption of 0.3 lb. per ton of train per mile. Referring to our table IX, and it will be seen that with one exception all the roads which reported the fuel consumption in hauling their heavy passenger trains show a lower rate of consumption than *The Engineer's* average on British roads. The rates, per ton per mile, given in the table referred to are 0.299, 0.298, 0.289, 0.274, 0.268, 0.257, 0.248, 0.227, 0.215, 0.197, 0.194, 0.183, 0.171, 0.166, and 0.146. The exception is the Baltimore & Ohio road on its heavy mountain grades, and on its fast train between Baltimore and Philadelphia, the second fastest train in the country, which burns 0.385 lb. per ton per mile.

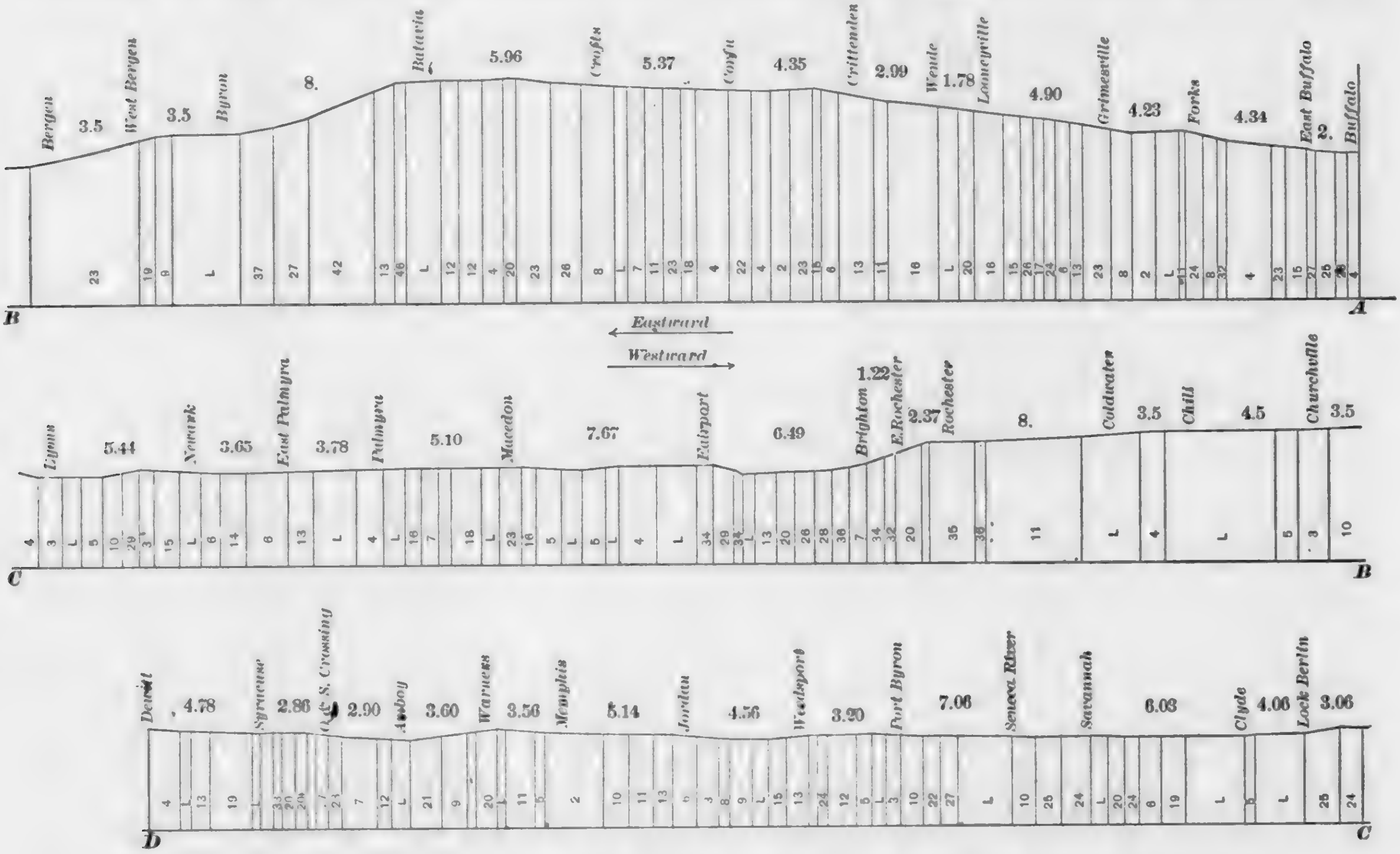
It may be said though that this is comparing what *The Engineer* is pleased to assume as the average consumption on British roads, with special trains on American roads, which would be true if our cotemporary's figures represented general averages, which we have shown they do not. But if we take the coal which is allowed on the Pittsburgh, Fort Wayne & Chicago road for running their passenger trains, which is somewhat in excess of the actual consumption—because some of the men are paid a bonus or premium for what they save out of the coal allowed—and we find that the amount is only 0.33 lb. per ton per mile, and on some trains as low as 0.19. Surely *The Engineer* must revise its statement that American locomotives burn nearly double the quantity of coal that

English engines do. If it could or would obtain any reliable statistical data concerning the average weight of *all* trains on its roads, then some comparison of general averages which would be conclusive might be possible, but mere conjecture is not proof.

Concerning freight trains *The Engineer* admits that they are considerably heavier in the United States than they are in its own country. "But," it is said, "on the other hand, they are run at slower speeds. In England speeds of 30 miles an hour are frequently exceeded by goods trains; even mineral trains are run now and then at that velocity."

Evidently the writer of what we have quoted is unacquainted with the practices which exist on some of our single-track lines with heavy traffic. The speed of a freight train on such roads is not likely to be strictly limited to any given speed when there is an express train before and another behind, which will be delayed unless the freight gets out of the way. Thirty miles an hour is quite a common speed for freight trains on nearly all of our roads.

In our table VII, published in December, in which the results of tests of freight locomotives on the North British and the New York Central Railroads were compared, the average weight of the cars and lading of the trains hauled on the latter line, it was stated, was 1,212 tons, and the maximum grade was 42 ft. per mile. *The Engineer* calls attention to the fact that it is impossible for a locomotive of the weight and dimensions given to haul a train of that weight up a grade of 42 ft. per mile. In this our cotemporary is right, and whatever controversial advantage accrues from the fact that in the report of these tests, which we quoted from, there was no intimation that a helping engine was used, and that we had no knowledge of that fact, and neglected to calculate the capacity of the engine, our cotemporary may rightfully claim. We have carefully inquired into the conditions under which the tests were made, and have found that an assisting engine was used in the westward trips from Byron to Batavia, a distance of eight miles. The accompanying profile shows the contour of the line on which the tests were made. No helping engine was used on the eastward runs, and unfortunately no account was kept of the fuel consumption of this helping engine, nor was the fuel consumption during the eastward and westward runs kept separately. No correction of our figures is therefore possible. As the engine on the North British road burned nearly 2½ times as much coal per ton of load hauled as the New York Central engine, and as the total cost of locomotive expenses and train service per ton hauled of the former engine was more than four times that of the latter, there is ample margin for making any correction due to the use of the helping engine for a distance of only about 2½ per cent. of the whole distance run.



PROFILE OF WESTERN DIVISION, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

NOTE.—The figures above the base line indicate the rate of grades in feet per mile.

The writer in *The Engineer* also calls attention to the fact that Mr. Buchanan's engine on the New York Central road burned only 0.105 lb. of coal per ton per mile, the average consumption on the 12 roads reported in our table V burned 0.215 lb. To any one who has ever studied locomotive reports this will not cause surprise. The roads named in table V own nearly 5,000 locomotives, and the consumption of coal reported therein is that of all of these engines, good, bad, and indifferent, and working under all sorts of conditions, grades, curves, etc., favorable and unfavorable. It illustrates the importance in comparisons of this kind, as has been mentioned before, of confining

them either to general averages or to special tests made under like conditions. *The Engineer* constantly confuses these two kinds of data, and, in fact, seems to have a misapprehension of the meaning of the word "average" when it is used in the sense of a medial sum or quantity. Thus, in speaking of the average weight of English goods trains, he says that we are mistaken in thinking that 233 tons represent about the average English goods trains. "Coal trains of 450 tons," he says, "are very common in this country, and if we grant that 60 lbs. per mile is burned with such trains, we have less than 0.14 lb. of coal per ton-mile, which is not greatly in excess of one-half that burned by American engines."

But why should we grant *The Engineer's* assertion? He does not give the slightest evidence to lead us to do so. But even if *some* engines pull trains of 450 tons weight with a consumption of 60 lbs. of coal per mile, it does not prove that *all* freight trains on English roads burn that amount of fuel per ton per mile. The reasoning is feeble and fallacious. It is a case of what logicians call a "non-distribution of the middle term."

In the article which appeared in *The Engineer* of March 4, our cotemporary, commenting on some of the data which we gave in our table IX * showing the maximum loads hauled, with weight and performance of locomotives, on different American railroads, says:

It must be clearly understood that this table does not represent average performance. It shows the heaviest loads hauled, and some of the figures given cannot be received without considerable hesitation. Let us take, for example, the New York Central train. This, according to the table, weighs 392 tons; the weight of the tender is, we assume, included in this. The engine weighs about 44 tons. So the gross load moved is 436 tons. The tractive power of the engine is, in round numbers, 105 lbs. per pound of average cylinder pressure; the speed is over 37 miles per hour. The resistance at this speed cannot, we think, be less than 20 lbs. per ton, and $436 \times 20 = 8,720$ lbs., demanding an average pressure of about 83 lbs. effective in the cylinders. A resistance of 8,720 lbs. overcome at the rate of 3,256 ft. per minute represents 860 horse-power expended in hauling alone. But experiments very carefully conducted in the United States have shown that the indicated power is not infrequently twice as great as that represented by the pull on the draw-bar. If, however, we make the very moderate estimate that the power expended in the internal resistances of the engine was but 140 horses, we have 1,000 horses left, as the average indicated power of the locomotive. Unfortunately the consumption of fuel per mile is not given. That of a larger engine is, however, given lower down at 95 lbs. per mile. Assuming that the New York and Albany engine burned the same weight, we have $37 \times 95 = 3,515$ lbs. of coal for an hour's work, and 3.515 lbs. only per horse-power per hour. But it is a liberal estimate to say that the boiler made 7 lbs. of steam per pound of coal, so that notwithstanding the enormous average pressure, which must have greatly limited expansion, the engine was running with only 24.6 lbs. of steam per horse per hour. This is indeed a wonderful performance altogether—so wonderful that our cotemporary ought to investigate the facts. If it can be really proved that the figures he gives represent the truth, then the New York and Albany locomotive deserves to be reproduced over and over again. As it is, without meaning to be discourteous, we are compelled to say that the figures cannot possibly represent facts without qualification.

It is not easy to know just how to discuss a subject with a person in the condition of mind which is manifested by the close of the above paragraph. A reply thereto should be preceded by the statement that the Hudson River Division of the New York Central Railroad is nearly level from New York to Albany. There are some short grades of from 15 to 34 ft. per mile, but they are so short as not to materially affect the capacity of engines, and others of 9 to 10 ft. per mile and 2 or 3 miles long. Now the engines specified in our table have taken trains of the size and weight from New York to Albany in the time named, and we are authorized by Mr. Buchanan, the Superintendent of Machinery of the road, to say that if the Editor of *The Engineer* will visit this country or send a representative, he, Mr. B., will take great pleasure in hauling such a train from New York to Albany with one of the engines specified in our table, and with his foreign visitor as a passenger.

* Published in February.

Esteemed cotemporary, it is not our figures which "cannot possibly represent facts," it is yours. You have assumed that the resistance of the passenger cars on the Hudson River Railroad cannot be less than 20 lbs. per ton at a speed of 37 miles per hour. It is probably less than 15 lbs.

Again, our cotemporary discredits the fact, given in our table IX, that Mogul engines on the New York Central Railroad haul trains from Buffalo to New York, a distance of 440 miles, which weigh 1,800 tons. Of this performance *The Engineer* says:

The table of freight trains presents many figures with which we in Great Britain have nothing to compare. As, for example, 1,800 tons hauled at 29 miles an hour. It is, we think, beyond question that the resistance per ton of goods trains is greater than that of passenger trains at moderate speeds, because the wheels are not kept in such good order, the axle-boxes are less carefully lubricated, and there is more jolting and striking of flanges against the rails. We shall probably not be over the mark—though we are open to correction—if we take the resistance of engine and train together at 20 lbs. per ton. But this means a resistance of 36,000 lbs., and this resistance overcome at the rate of 1,760 ft. per minute represents about 1,900 horse-power. A small addition for internal resistance gives us 2,000 indicated horse-power. The engine has cylinders 19×26, and its tractive power is in round numbers 147 lbs. per pound of average pressure, so the average pressure cannot have been less than 244 lbs. on the square inch. We willingly admit that we have nothing in this country at all comparable with this. If it be argued that 20 lbs. is an excessive resistance, then it is clear that goods trains run with much less friction than passenger trains. A great road resistance is the only excuse for the enormous consumption of fuel in passenger engines. Why should not the same resistance exist for goods trains? We have not said anything about the weight of the engine in this case, which amounts to about 53 tons—a trifle, of course, compared to the weight of the train. Once more we have to plead incredulity. We really cannot manage to believe that a locomotive of the dimensions stated hauled 1,800 tons at 30 miles an hour, especially as there is a maximum grade of 30 ft. to the mile, or 1 in 176 to be dealt with, but whether the train went up this or down is not stated. Nothing is said about the weight of the coal burned.

It is true that a correction of our statement is required. On more careful inquiry than was given to the first report which was received of this performance, we find that pushing engines are used at four places between Buffalo and New York: first, from East Buffalo to Forks, a distance of 4½ miles; second, on the grade west of Fairport, a distance of 1 mile; third, east of Oneida, 1 mile; and fourth, from Schenectady to Athens Junction, for 3½ miles. The whole distance from East Buffalo to New York is 440 miles. On reinvestigation we find, however, that our estimate of the average weight of cars hauled in these trains is below and not above the actual weight. Many of the cars carry over 50,000 lbs. of lading, and the cars themselves weigh 30,000 lbs. With the exception of the places named, such trains are hauled daily on the New York Central line by Mogul engines of the weight and dimensions given in our table.

Since our former articles were written we have received reports of other heavy trains hauled on different roads, the data of which are given in the accompanying table. These

TABLE SHOWING THE MAXIMUM LOADS HAULED, WITH THE WEIGHT AND PERFORMANCE OF LOCOMOTIVES, ON DIFFERENT AMERICAN RAILROADS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NAME OF ROAD.	TERMINAL POINTS.	Distance between Terminals.	Number of Loaded Freight Cars Hauled.	Number of Empty Freight Cars Hauled.	Number of Mail, Baggage, Express or Postal Cars Hauled.	Number of Coaches Hauled.	Number of Drawing-Room, Sleeping or Dining Cars Hauled.	Total Number of Cars Hauled.	Weight of Cars and their Loads in Tons of 2,240 Lbs.	Maximum Grades on Run.	Schedule Time, including Stops.	Kind of Engine Employed. ‡	Total Weight of Engine in Working Order.	Total Weight on Driving-Wheels.	Diameter of Driving-Wheels.	Size of Cylinders.	Coal Consumed per Mile.	Coal Consumed per Ton of Train Exclusive of Engine and Tender.	Proportion of Weight of Engine to Weight of Cars Hauled.	Miles per Hour.
PASSENGER TRAINS.																				
		Miles.							Tons of 2240 lbs	Ft. per m.	H. M.		Lbs.	Lbs.	In.	In.	Lbs.	Lbs.		
Baltimore & Ohio	Baltimore & Martinsburg	114	...	....	4	3	3	10	....	....	2 56*	Am.	102,000	70,000	66	19 × 24	....	....	....	....
" "	Piedmont & Altamont	17	....	....	2	2	1	5	....	117†	.. 43⅜	"	102,000	70,000	66	19 × 24	....	....	....	....
" "	Sandusky & Newark	115.6	....	....	1	18	....	19	485⅛(a)	48‡	4 32 (c)	10-wheel.	127,500	101,500	60	20 × 26	....	....	8.5	....
" "	Newark & Columbus	33	....	....	1	18	..	19	485⅜	47§	1 05 (d)	"	127,500	101,500	60	20 × 26	....	....	8.5	....
" "	Columbus & Newark	33	....	....	1	18	..	19	485½	51 (b)	1 27 (e)	"	127,500	101,500	60	20 × 26	....	....	8.5	....
" "	Newark & Sandusky	115.6	....	....	1	16	....	17	435½	....	6 5 (f)	"	127,500	101,500	60	20 × 26	....	....	7.6	....
Phil. & Erie Div., Penn. R R., and Nor. Cent. R.R	Harrisburg & Williamsport	93	....	....	4	4	3	11	256.8	10 8	3 20	Am.	103,600	65,400	68	18 × 24	59.13	.23	5.5	....
Chicago, Milwaukee & St. Paul.	Milwaukee to Chicago	85	..	....	3	3	5	11	412.5	35	2 30	"	100,000	64,100	69	18 × 24	....	....	9.2	....
FREIGHT TRAINS.																				
Chicago, Milwaukee & St. Paul	Milwaukee & Chicago	85	35	....	....	....	....	....	906.2	35 (h)	6 ..	Am.	100,000	64,100	....	....	....	....	20.3	....
" " "	" " "	85	43	....	....	....	....	....	1170	35 (h)	6 ..	10-wheel.	117,000	84,800	....	....	....	....	22.4	....
Phil. & Erie Div., Penn. R.R , and Nor. Cent. R.R	Sunbury to Honey Pot	53.5	23	45	....	....	....	....	1077.9	22.7 (g)	5 20	C'nsolidat'n	95,700	82,700	50	20 × 24	199.06	.185	25.2	....
"	Rockville to Sunbury	46.7	28	72	....	....	....	....	1280	8.7 (g)	4 10	"	95,700	82,700	50	20 × 24	256.95	.200	29.9	....
"	Honey Pot to Sunbury	53.5	65	....	....	....	....	....	1788.2	30.6 (g)	4 32	"	95,700	82,700	50	20 × 24	199.06	.111	41.8	....
"	Sunbury to Rockville	46.7	75	....	....	....	....	....	2422	7.5 (g)	4 20	"	95,700	82,700	50	20 × 24	329.76	.132	56.7	....
"	Honey Pot to Sunbury	53.5	75	....	....	....	....	....	2764.7	22.7 (g)	4 32	"	124,800	110,000	50	20 × 24	340.6	.123	49.6	....

* Including 4 stops. † This grade is continuous for 17 miles with sharp curves. ‡ This is the maximum grade for a distance of 3 miles. § This grade is 4 miles long. (a) This includes the weight of 1,325 passengers in the train. (b) Grade about 6 miles long. (c) Including 11 stops. (d) Including 1 stop. (e) Including 1 stop. (f) From Newark to Sandusky the train was run as an extra, and took side tracks for all regular trains. (g) The grades on this portion of the road, although the number of feet per mile exists for short distances of from 500 to 1,400 feet; in other words, the road has a number of short dips, but the general character of the grade is gradual descending from Honey Pot to Sunbury, following approximately the fall of the Northwest branch of the Susquehanna River. The road is very crooked over most of the distance, so that the curve resistance is in most cases more serious than the short grades. (h) Have 2 grades of 35 ft. per mile. Freight trains have a pushing engine up the first one, 2¾ miles long, but none up the second one, which is 1½ miles long.

reports are given on the authority of the Superintendents of Machinery of the lines on which the trains were hauled. It will be seen from this that a passenger train weighing 485½ tons was hauled on the Baltimore & Ohio Railroad, and on the Philadelphia & Erie freight trains of 2,422 and 2,764.7 tons have been hauled with consolidation engines. This line, it may be said, is nearly level, with a few grades and a slight descent in the direction in which the trains were hauled.

But our esteemed adversary has reserved its most overwhelming argument for the last. To explain the fact, which we have proved by statistics, that American locomotives run farther, pull heavier loads, and cost less for repairs, he says they must therefore wear out sooner. Surely it cannot be expected that we will seriously answer such reasoning. Esteemed cotemporary, how do you know they wear out sooner? who told you they did? or—what is probable—did you only imagine they do? what evidence have you to show that they are short-lived? There are locomotives in this country which have been in continuous service for over fifty years. Are there any English engines of that age in service? No table of mortality has ever been constructed to show an average "prospect of life" of American locomotives; but, esteemed cotemporary,

seriously, if they wear out faster the expense of renewals ought to show in the repair accounts, because all companies, in this country, which keep their accounts properly, charge renewals of old engines to "repairs." Now, as the repairs of our engines cost less than yours do—even with more costly material and higher wages—it would seem to show that in reality they are longer-lived than yours. You say that we "do not attempt to explain why an American locomotive should last longer and cost less for repairs than its English rival." We can't explain the reason for a fact which does not exist. It is perhaps not very important either that it should be explained to parties like the Indian Locomotive Superintendent, whose letter is published on another page, provided the fact is proved, as we think it has been in these articles. In the future we hope to be able to make what we may call anatomical comparisons of the details of a representative English and American locomotive. We have been promised complete drawings of an English and of a corresponding America express engine, and as soon as they are received we intend to give our readers engravings of them and will then discuss the comparative anatomy of the two breeds of machines. Until then you and some other Englishmen and we and all other Americans may repose in the conviction expressed at the end of your discussion of this subject, that "Our locomotive is adapted to our requirements, and the locomotive of the United States to the requirements of Brother Jonathan." But how about the railroad managers

"From Greenland's icy mountains,
To India's coral strand,
or Where Afric's sunny fountains
Roll down their golden sand"?

—those are the people who are, or should be, open to conviction, and who will be interested in knowing that this discussion has shown that American locomotives *run farther in a given time, pull more, cost less for repairs, burn less fuel in proportion to the loads hauled, and last longer than English locomotives do.*

NEW PUBLICATIONS.

THE COAL TRADE. *A Compendium of Valuable Information Relative to Coal Production, Prices, etc.* By Frederick E. Saward. The *Coal Trade Journal*, New York.

This is the nineteenth number of Mr. Saward's very useful annual publication. It is what the title claims—a compendium of information relating to the coal trade, giving production, range of prices, and a great deal of other useful information.

The statistics given seem to be the best available. For the anthracite coal field and for some of the Eastern bituminous districts—such as the Clearfield, Cumberland, and a few others—complete figures are attainable for production and shipments; but for many of the Western coal fields it is impossible to give more than approximate and estimated statements. Mr. Saward's long experience in the trade has enabled him to make an excellent book, and to know where to look for the most reliable information, and it is an indispensable book of reference for all who are connected with or interested in the trade.

A TEXT-BOOK ON RETAINING WALLS AND MASONRY DAMS. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. John Wiley & Sons, New York; price, $2.

This book is intended for the use of civil engineers, as well as for a text-book for students, and its author's object has evidently been to treat his subject in as brief and compact a way as would be consistent with clearness. It includes chapters on Earthwork Slopes; Lateral Pressure of Earth; Investigation of Retaining Walls; Design of Retaining Walls and Masonry Dams. The various principles and formulas stated are illustrated by numerical examples in almost every case.

The book sets forth the best methods of computing the thrust of earth against walls, of investigating strains on walls and dams, and of designing structures of that kind. It is concisely and yet clearly written, for Professor Merriman has always the gift of expressing his meaning plainly, and is altogether an admirable text-book on a somewhat difficult subject.

TRADE CATALOGUES.

Bending and Straightening Rolls for Iron and Steel Plates: Illustrated Catalogue. The Niles Tool Works, Hamilton, O.

This catalogue gives descriptions of a number of tools of the class named, including some very heavy and powerful machines, built especially for bending ship and armor plates of the largest size. It is very handsomely illustrated.

Griffith's Stopper and Nozzle for Open-hearth and Bessemer Steel Ladles. R. B. Seidel, 1324 *Callowhill Street, Philadelphia.*

This is an illustrated description of an excellent device, which was described in the JOURNAL some time ago, and which has now proved its usefulness in service.

Illustrated and Descriptive Catalogue of the Nathan Manufacturing Company: New York.

This very handsome catalogue is the first issued by the Nathan Company for several years, and it contains descriptions of several new devices which were not in the last edition. These include a steam fire extinguisher; a steam sanding apparatus; a boiler washer and filler; and the new "Nathan" injector, which we expect to illustrate shortly in our columns. The illustrations are very good, and the catalogue generally is an exponent and example of the excellent work for which the Company is noted.

Comparative Boiler Tests at the Rochester (N. Y.) Railway Company. The Heine Safety Boiler Company, 421 *Olive Street, St. Louis.*

This is an account of some competitive tests of safety boilers made recently in Rochester, N. Y., with the object of determining the efficiency of the Heine boiler as compared with others of the same type.

Brass and Iron Goods and Specialties: Illustrated Catalogue of the Lunkenheimer Brass Manufacturing Company, Cincinnati, O.

This catalogue contains descriptions of a great variety of articles, including valves of all kinds, fittings, oil-cups, etc., including a variety of specialties, such as the "handy" gate valve; sight-feed lubricators and other devices. The Company represented by the catalogue has a very large plant, and facilities for doing a great variety of work.

The Acme Water Lift: Illustrated Catalogue. Burt & Skilton, Patentees, Jacksonville, Fla.

This is an illustrated description of a device for raising water, which has been heretofore described in the JOURNAL, and which is very well adapted for railroad use, especially at stations where it is not convenient to keep a steam-pump or engine. Water can be raised and tanks filled readily by passing locomotives.

Illustrated Catalogue of Graphite Productions. The Jos. Dixon Crucible Company, Jersey City, N. J.

This catalogue gives one a new idea of the variety of purposes to which graphite can be applied. The Jos. Dixon Company is a leader in this branch, and has not only supplied graphite in its purest form, but has made for years a study of the different methods of using it in the arts. The catalogue should be studied, for it is quite impossible to give more than a general idea of its varied contents within the limits of a brief notice.

The Improved Drawing Table and the Multilinead: Illustrated Description. John Svenson, M.E., Scranton, Pa.

CURRENT READING.

In the June number of the POPULAR SCIENCE MONTHLY Mr. Andrew D. White continues his articles on the Warfare between Science and Theology. Professor John S. Newberry contributes a sketch of the Ancient Civilizations of America, and Mr. A. Morgan writes of the necessity of a Railroad Court of Last Resort to construe the many and frequently conflicting National and State laws relating to railroads. There are also several other interesting articles.

In the FORUM for May the Silver Question is discussed by Senator Vilas, Representative Harter and Mr. J. C. Hemphill, of Charleston. Mr. S. C. T. Dodd pleads the cause of the Standard Oil Trust, and Mr. D. R. Wilkie, General Manager of the Imperial Bank of Canada, discusses the advantages of the Canadian Banking System. An article of especial interest to engineers is Mr. Edward P. North's paper on Ocean Traffic by the Erie Canal. Mr. North groups his statistics well and makes a plea for the enlargement of the Erie Canal which is in some respects effective, but is unfortunately marred by some defective reasoning; it is, however, a readable paper.

With the May number the ARENA completes its fifth volume. In the two and a half years of its existence this magazine has been remarkably successful, simply because its editor has adhered closely to the original intention of keeping its pages open to the free and full discussion of important questions. It has enlisted many contributors of ability, and has taken a high position on this account. The May number is fully up to the high standard set, and promises continuous improvement.

Several very finely illustrated articles are found in HARPER'S MAGAZINE for June, and the number contains even more than the usual variety. The Austro Hungarian Army is described by one of its officers. The paper in the Western series is on Montana, and there is one on Eastern Peru, a country almost unknown to most of us. The lighter part of the magazine is appropriate for an early summer number.

The June number of the OVERLAND MONTHLY is a very good one, both in matter and illustrations, and shows that this magazine is keeping up to a high standard.

The May number of OUTING is bright and brings with it a pleasant suggestion of coming summer. The Bicycle, Riding, Canoeing, Fishing and Hunting all find place in its columns, and there are some excellent illustrations. The evolution of the new form of fast yacht is traced in a carefully written article. The Maryland National Guard is the subject of the military article for the month.

The number of the COMMERCIAL AND FINANCIAL CHRONICLE for May 21 is accompanied by the yearly SUPPLEMENT giving State and city debts. This is the only publication giving full information about issues of State and municipal bonds; it is prepared with great care and is of the highest value to investors, with whom this class of securities is very popular.

Among books in preparation by John Wiley & Sons, New York, we note a new volume on GEODETIC SURVEYING by Professor Mansfield Merriman.

In recent numbers of HARPER'S WEEKLY there have been illustrated articles on the Memphis Bridge; on the Mining Regions of Alaska; on the Columbia River Centennial, and a number of other interesting topics.

The May number of the ECLECTIC MAGAZINE has an excellent selection of articles from the leading English periodicals, including two or three that deserve especial attention.

The May number of the ENGINEERING MAGAZINE has some interesting articles, including illustrated papers on the Future World's Highway, by T. G. Gribble; Difficulties of Tunnel Building, by Emil Low; Education for the Workshop, by P. A. C. Perrine; Water Supplies for Cities and Towns, by Floyd Davis. The special departments have been put in editorial charge of gentlemen who are experts in their several subjects.

A number of excellent articles are found in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for May. Among the subjects treated are Glaciers; the Appalachian Mountains of Pennsylvania; River Valleys; Volcanic Forces and Submarine Cables; the Physiology of a Pocoson, and the history of Columbus. The number has general as well as special interest and is bright and readable.

In the June number of SCRIBNER'S MAGAZINE Mr. Thomas C. Clarke has an article suggesting a solution for the problem of rapid transit, especially in New York, Boston, and Chicago. Other articles describe an ascent of Mt. Etna, the Chicago fire of 1871, and the great Texas Cattle Trail, which has now almost disappeared. There are also some other articles of interest, besides the usual amount of fiction and lighter material.

In the May number of GOOD ROADS Mr. J. M. H. Frederick has a paper on the Roads of Ohio, which is illustrated by some very striking photographs of country roads of various degrees of badness. There are also papers on Broad Tires, on Dirt Roads and Gravel Roads, and several other timely topics.

The May number of MINERALS has articles on Mount Mica; on New Minerals discovered; on the Origin of Diamonds; on Minerals of Spanish America; Minerals at the World's Fair; and a variety of shorter notes on various topics.

BOOKS RECEIVED.

Ninth Annual Report of the Board of Railroad Commissioners of the State of New York for the Year ending June 30, 1891. William E. Rogers, Isaac V. Baker, Jr., Michael Rickard, Commissioners. State Printers, Albany, N. Y.

First Report of the United States Board on Geographic Names. 1890–91. Government Printing Office, Washington.

United States Naval Institute: Additions, Changes and Corrections in Instructions for Infantry and Artillery, United States Navy, 1891. Published by the Institute, Annapolis, Md.

Liste des Batiments de la Marine Française (Guerre et Commerce) et de Leurs Signaux Distinctifs. Janvier 1, 1892. Service Hydrographique de la Marine. Imprimerie Nationale, Paris, France.

Second Annual Report of the Board of Directors of the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad Company; for the Year 1891. Pittsburgh.

The Railroads and the Public: Addresses delivered before the Contemporary Club by George G. Crocker, Joseph D. Potts, Joseph S. Harris and George B. Roberts. Privately printed for the Contemporary Club, Philadelphia.

Annual Report of the City Engineer of the City of Providence for the Year 1891. *J. Herbert Shedd, City Engineer.* Issued by the City, Providence, R. I. This report contains much valuable information, to which we hope to refer at more length hereafter.

Catalogue of the Officers and Students of Washington University, with the Courses of Study for the Academic Year 1891–92. Issued by the University, St. Louis.

Report of the United States National Museum under the Direction of the Smithsonian Institution. Government Printing Office, Washington. Some reference has heretofore been made to this report.

University of Wisconsin: Circular of the College of Mechanics and Engineering. Published by the University, Madison, Wis.

Tenth Annual Catalogue of the Rose Polytechnic Institute; with an Outline of the Course of Study and the Plan of Instruction. 1892. Issued by the Institute, Terre Haute, Ind.

Proceedings of a National Convention of Railroad Commissioners, held at the Office of the Interstate Commerce Commission, Washington, D.C., April 13 *and* 14, 1892. Washington; issued by the Interstate Commerce Commission.

Statistical Abstract of the United States: Fourteenth Number, 1891. *Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Population, Railroads, Agriculture, etc. Prepared by the Bureau of Statistics under the Direction of the Secretary of the Treasury.* Government Printing Office, Washington.

The Americus & Tampa Railroad Company: Prospectus. Compiled by Judge Joseph Tillman, President. Issued by the Company, Americus, Ga.

Annali della Societa degli Ingegneri e degli Architettetti Italiani: Anno VII, 1892, *Fascicolo I.* Issued by the Society, Rome, Italy.

Design Patents: Liability of Infringer. United States Circuit Court Southern District of New York. Opinion of Judge Coxe in the case of Untermeyer vs. *Freund and others.* New York.

THE INTERCONTINENTAL RAILROAD SURVEY.

THE first surveying party for the Intercontinental Railroad, which is under charge of Mr. W. F. Shunk, has completed a preliminary survey from Quito in Ecuador to Medellin in Colombia, and has recently been instructed to continue the line from the last-named point to Cartagena, with especial reference to determining the best practicable route.

The party under charge of Mr. W. D. Kelly is now at Cerro di Pasco in Peru, and is about to begin the survey of a line from that place to Cuzco and thence southward into Bolivia.

These two surveys, when completed, will, with those already made, determine the practicability of the Intercontinental Line from Cartagena to a connection with the Argentine railroad system, and will cover nearly all the proposed line in South America. The preliminary work will probably be finished within a year.

Something depends, of course, on the money which may be available for the work; but it is understood that there is now little doubt that a sufficient appropriation can be secured for the present year. The work completed so far covers about 1,600 miles of reconnoissance, and some 500 miles more are included in the two sections mentioned above.

SOME CURRENT NOTES.

THE Governor of New York has signed the bill passed by the Legislature which provides that 10 hours' work performed within 12 consecutive hours shall be considered a day's work for railroad men. For all over the 10 hours' work they are to be entitled to extra pay. It is further provided that no trainman who has worked 24 hours shall be required to go on duty again until he has had at least eight hours' consecutive rest. A fine not to exceed $500 is the penalty for any violation of the law, and the only exception permitted is in clearing tracks in cases of accident.

SOME trials have been begun at the New York Navy Yard with the torpedo-boat *Destroyer*, which was built some years ago. This boat was built for the purpose of testing the Ericsson submarine gun, which is intended to throw a formidable projectile under water. The boat itself is 130 ft. long and 10 ft. beam; the gun is fixed firmly in the hull and is about 30 ft. long, with a caliber of 12 in. The projectiles are cylinders nearly 20 ft. long, provided with fins for directing their course, and carrying a heavy charge of explosive. This gun was one of the last inventions of the late John Ericsson, and from it he expected great results.

THE report of the State Engineer of New York gives an interesting history of the canal system of the State and its gradual development. It states that the improvements now in progress on the Erie Canal, the main trunk of the system, will give a full depth of 7 ft. of water throughout; this depth is at present reduced at several points by deposits of mud and silt. The locks are all to be made long enough to pass two boats, the general practice on the canal being to run two boats together. A steady increase in the number of steam canal-boats is reported.

THE Kansas City, Watkins & Gulf Railroad was completed on April 28 from Lake Charles, La., to Alexandria, a distance of 96 miles. This road has been located and built under the direction of Mr. P. H. Philbrick, Chief Engineer, and required some difficult work.

THE Chicago Elevated Terminal Railroad Company has had plans prepared for a large station building on the corner of Twelfth and State streets in that city. The main building is to be 269 × 350 ft. and eight stories high, and on the street corner there is to be a tower 60 ft. square and 420 ft. high. In the rear of the main building there will be a train-shed 269 × 1,000 ft., with 14 tracks and eight platforms. The main building will contain waiting-rooms and all necessary accommodations, and on the ground floor there will be a number of stores. The estimated cost of the building is $3,500,000 in all.

THE Rensselaer Polytechnic Institute at Troy has secured the services of Mr. Alphonse Fteley, Chief Engineer of the New York Aqueduct Commission, and of Mr. J. J. R. Croes to deliver lectures to its students during the next term.

A valuable collection of pamphlets relating to the construction and operation of the New York and Brooklyn Bridge has been presented to the library of the Institute by two of its graduates, Mr. C. C. Martin, now Chief Engineer, and Mr. G. Leverich, Principal Assistant Engineer of the Bridge.

THE Tramways Trust of the city of Melbourne, Victoria, began operations eight years ago, when there were no cable lines in Australia, and the only one in the colonies was a short line in Dunedin, New Zealand. The Trust now owns in Melbourne 43½ miles of cable road and 3½ miles of line operated by horses. The whole system has been constructed under the charge of Mr. G. S. Duncan, Chief Engineer, and that gentleman was recently presented with a handsome testimonial, on the occasion of his starting for a trip to England and the United States.

PLANS for the new bridge which the East River Bridge Company proposes to build between New York and Brooklyn, under the charter recently obtained from the

New York Legislature, have been prepared by Chief Engineer George B. Cornell, and have been approved by the Directors of the Company. The location of the bridge is about one mile further up than the present Brooklyn Bridge, and it will extend from a point near Delancey Street in New York to South Fifth Street in the Eastern District of Brooklyn. On the New York side the approaches will extend to a point near Willett Street, and it is proposed to continue an elevated railroad line from that point to the Bowery, connecting with the Second and Third Avenue lines of the Manhattan Company.

The plans provide for a suspension bridge of the same general character as the present Brooklyn Bridge. The piers will be of granite and will stand on the dock line provided by the City authorities. The top of the piers will be 280 ft. above the river. The masonry work will be carried up about 180 ft., and the remaining 100 ft. will be a steel structure. The main span between the piers will be 1,620 ft., or 25 ft. longer than that of the Brooklyn Bridge. The clear height above high water at the piers will be 120 ft., and in the center 135 ft. The width of the roadway, including side-walks, roadway for teams and four tracks for cars, will be 106 ft. The cables for the bridge will be four in number, and will be 19 in. in diameter.

DESIGN FOR NEW BRIDGE OVER THE EAST RIVER, NEW YORK.

As in all city structures of this kind one of the greatest sources of trouble and expense will be the right of way for the approaches and the land needed for the anchorage structures for the cable. It is stated that the officers of the Company are now engaged in securing the required property. The engineers are employed in making the necessary surveys and the borings to ascertain the character of the bottom at the points where the piers are to be built.

THE specifications for the new dry-dock at the New York Navy Yard are completed, and bids for its construction are to be received till July 12. It will be near the present timber dock.

When completed it will be the largest dock in this country. It will be 625 ft. long on the outside, 154 ft. wide at the top, 64 ft. wide at the bottom and 28 ft. deep. The foundation piers must be driven 45 ft. below the bottom of the dock. A bed of concrete not less than 2 ft. thick will cover the heads of the piles. The dock floor will be laid on stringers of yellow pine, secured to the foundation piles by bolts driven in the center of the piles.

The dock will be closed with a steel floating gate or caisson. The caisson will be 108 ft. in length at the top and 71 ft. long at the bottom, 25 ft. in breadth and 35 ft. in height. The dock pumps will have a capacity to discharge 3,000 gallons of water per minute. It will take in the largest vessels in the Navy, and will be an important addition to the Yard.

PIG-IRON production is decreasing somewhat, as had been expected. The *American Manufacturer's* tables show that on May 1 there were in blast 262 furnaces, having a weekly capacity of 175,343 tons—a decrease from April 1 of 18 furnaces and 12,766 tons production. The greater part of this reduction—nearly 90 per cent.—was in the coke furnaces. There is, however, still a very large increase over last year, as on May 1, 1891, there were only 231 furnaces in blast, and their total capacity was 116,586 tons, showing a gain in weekly production this year of about 50 per cent.

Since January 1 the average weekly production of pig iron has been decreased over 8 per cent. It is still large. however, being at the rate of 9,000,000 tons a year. Stocks on hand are not increasing, and not much further decline in production is to be expected.

THERE is to be a convention held in St. Louis, June 2, for the purpose of advocating the speedy construction of the Nicaragua Canal under the control and direction of the United States. It is expected that delegates will be present to represent the commercial organizations of all the important cities of this country, and that some prominent men will take part in the proceedings.

THE success of nickel-steel in recent armor-plate trials has suggested the use of this alloy for guns, and it is understood that the Navy Department has ordered a set of forgings from the Bethlehem Iron Company for the purpose of making a cannon of nickel-steel, which will be subjected to a very thorough series of tests.

THE irrigation of a large extent of land, now uncultivated, in Upper Egypt is proposed by a French engineer. His plans include a series of dams on the Nile above Assouan, by which a chain of storage reservoirs can be formed, where the water will be held in reserve until the season when it is needed. These dams will not prevent the passage of the water required by Lower Egypt from the great river.

THE double-truck compound locomotives designed by Mr. T. W. Johnstone, Superintendent of Motive Power of the Mexican Central Railroad, are to be tried on that road, a contract to build three of them having been let by the Company to the Rhode Island Locomotive Works in Providence. These engines were recently described.

Mr. Johnstone is now making another careful comparative test of simple and compound locomotives on his road. It is to be thorough in its methods and interesting results are expected.

A VERY remarkable train was recently dispatched from Philadelphia to Chicago by the Baldwin Locomotive Works. The train consisted of 20 compound locomotives built for the Chicago & South Side Elevated Railroad; these engines are Forney locomotives of the Vauclain four-cylinder type, having cylinders 9 in. and 15 in. in diameter by 16 in. stroke, 42-in. driving-wheels and 26-in. truck wheels. They weigh 56,000 lbs. each, 40,000 lbs. being on the drivers, and were specially designed for this elevated railroad work.

The train was drawn by compound locomotive No. 82, with which experimental work has been done on several roads. This is a ten-wheel engine, also a compound of the Vauclain four-cylinder pattern; it has cylinders 14 in. and 24 in. in diameter and 24 in. stroke, and the six driving-wheels are 72 in. in diameter. This engine and its tender weigh about 200,000 lbs. in working order; the weight of the 20 small locomotives, without coal and water, was about 1,000,000 lbs., making the total weight of the train 600 tons.

The train was in charge of traveling engineers from the Baldwin Works, and relays of engineers and firemen were provided to run No. 82, so that it made the trip continuously, with only the necessary stops.

ENGLISH AND AMERICAN LOCOMOTIVES.

In the London *Engineer* for April 22 the following letter on this subject was published, addressed to the Editor of that periodical :

Sir : I have to thank the Editor of the Railroad and Engineering Journal, New York, for marked copies of his Journal containing the articles on English and American locomotives, which you have since noticed editorially.

I am not at all desirous of entering into argument with either him or you on the general merits of the question. I may, however, say this much, that I believe it to be wholly a paper war between the editors of rival national engineering newspapers, and that there is not a pin to choose between either English or American engines, so far as the work either can do for a given quantity of fuel. Exactly the same may be said of other locomotives—French, German, or Italian. Whether as Englishmen we care to commit ourselves to all the fearful and wonderful gims and notions characterizing foreigners' engines is a totally different question.

I, however, wish to point out that in dealing with Indian railways in his January number, your contemporary has drawn wrong deductions from the figures quoted. I will point out where he has done so, not merely for the sake of putting him right, but just to show the worthlessness of his manipulating statistics in order to bolster up an argument on a matter of which he has no knowledge of details, to say nothing of using the figures wrongly.

Firstly, then, by making assumptions that were unnecessary, to allow for what he calls "switching" service, but what in English we call shunting and miscellaneous service, he makes out that the average yearly mileage of an engine in India is 23,265. If he will turn to statement No. 38 in "The Director-General of Railways Report for 1890–91," from which he quotes, he will there find the full service of engines given in "engine mileage," without any need for any assumptions for "switching" service. Taking out the total average, he will find it as follows :

$$\text{Standard gauge (5 ft. 6 in.)} = \frac{41{,}450{,}792 \text{ miles}}{2{,}370 \text{ engines}} = 17{,}500$$

engine-miles yearly.

$$\text{Meter gauge (3 ft. } 3\tfrac{3}{8} \text{ in.)} = \frac{16{,}951{,}602 \text{ miles}}{1{,}006 \text{ engines}} = 16{,}850$$

engine-miles yearly.

$$\text{Both gauges} = \frac{58{,}402{,}394 \text{ miles}}{3{,}376 \text{ engines}} = 17{,}300 \text{ engine-miles}$$

yearly.

So you see he was far too liberal. At the same time we are not at all ashamed of this mileage. We run our engines entirely on the "one-man-one-engine" principle, and therefore the above mileage represents what one engine with the same engineman can do. We all know, without being taught by Americans, that by keeping the engines running longer, by putting on double crews, or by working the engines in and out with the first men to hand, it is possible to get lots more work out of an engine. Except, however, in the case of a few lines, this system cannot be worked in India, or at the most only for a few months in the busy season. Even where possible to so work, the wear and tear and fuel consumption is very heavy. Enginemen do not take any pride in an engine that does not "belong" to them, and it gets knocked all to pieces. I have myself worked the double-crew system, and know all its advantages and disadvantages. About 10 years ago, being short of engine-power on a small meter gauge line in this country—India—I got an average of over 18,000 miles out of a batch of 14 goods engines in six months—that is, over 36,000 miles yearly out of meter gauge engines. That, I fancy, will be hard to beat, even in America. We earned 13 per cent. during that half year on the capital of the line. The work, however, for the men during the height of the hot weather was killing. Each engine had a double crew which traveled in a specially fitted carriage in the train, and the men went on and off duty just like engineers at sea, and they thus kept running for four days at a stretch till the engine needed a wash out. They then got one day at their home station. India is not America, and I should be sorry to try such an expedient in such a furnace of a country again. It was, however, the only way to tackle an abnormally heavy grain traffic that year, and the engineman who howled the loudest at the severity of the work was an American. I tried to comfort him with the reflection that we were for once working on Yankee principles, but he would not see it at all.

Secondly, your American contemporary says that Indian railways are not profitable to their owners, and proceeds to suggest that if equipped and worked with American rolling stock all this would be altered. Let him see Chap. I., paragraph 19, of the same report, whence he will learn that, taken all round, they earn a shade under 5 per cent. per annum. How is this for profit? Is the American average as high? Apparently he has got a bit mixed over the "loss to the State" due to fall of silver, by its having to pay interest in England on gold liabilities to certain guaranteed railway companies. In that case the "owners" in England really get more profit than is their proper due—for the depreciation of silver so called is really an appreciation of gold. Some of the companies earn as much as 7 per cent. to 9 per cent. Under these circumstances neither the State nor English shareholders are likely to make any radical changes in the way of rolling stock.

Thirdly, his assertions that the average consumption of coal is 41.67 lbs. per train mile, and that the average tonnage of a goods train was only 116.7 tons, are both incorrect. In the first place, he apparently gets these figures by striking an average of the averages of the several lines, which of course does not represent the average for the total mileage and tonnage at all. Such to be correct should be worked out from the totals direct. Further, he has mixed up railways of both broad and narrow-gauge, which of course renders his figures entirely illusory. He complains that he does not know if the "gross tons" include or exclude the weight of engines and tender. They of course include all dead weight, or otherwise they would be "net" tons, not "gross" tons.

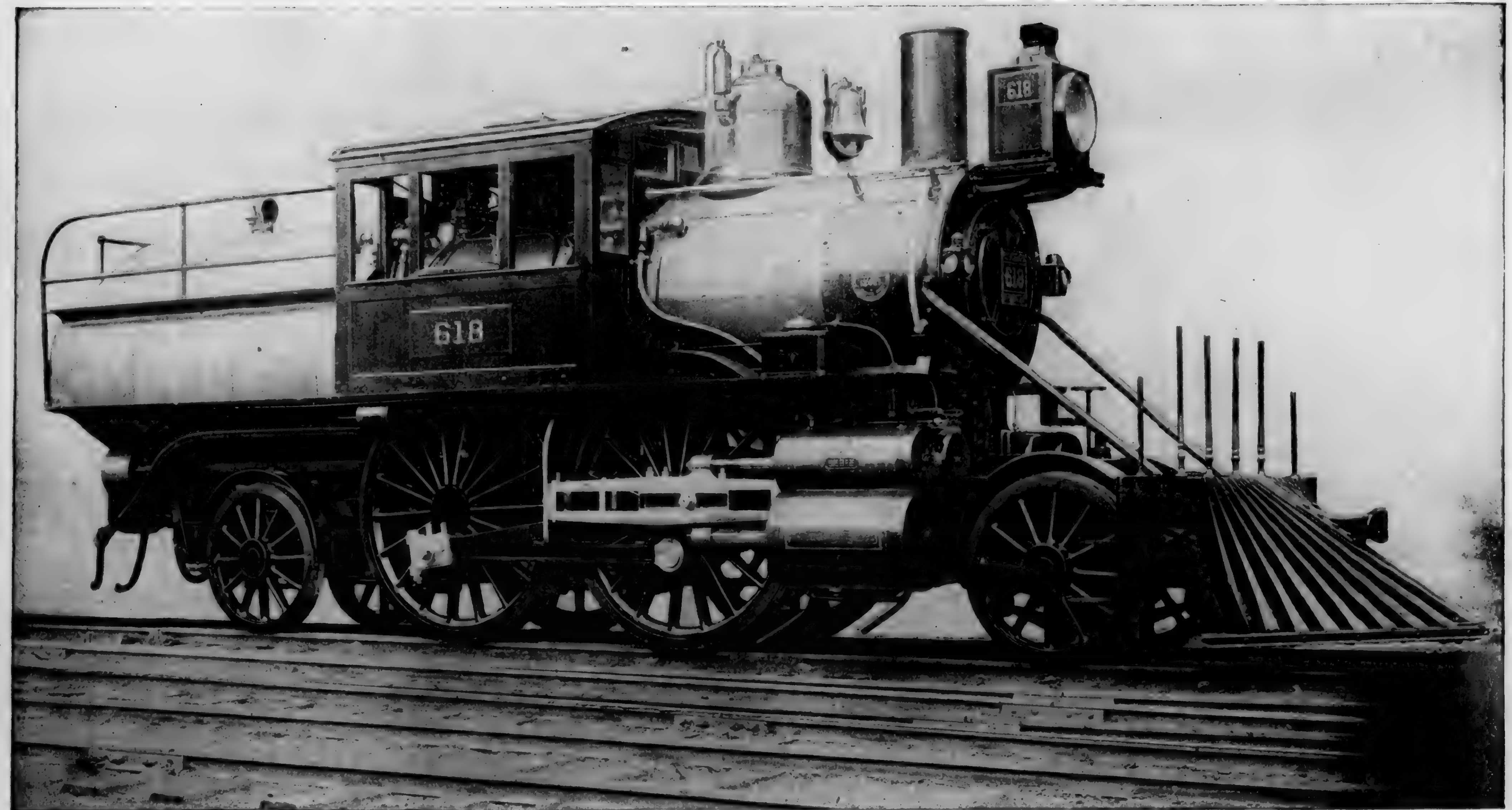
In conclusion, I beg to challenge his assertion that American locomotives, if put on Indian railways, "would run 50 per cent. more miles in a given time, and pull heavier loads." I have already shown that it is a question of men and human endurance—not of engines—that limits the performance of the latter. As, however, I suppose he has some American locomotive builders at his back, for whose benefit his articles have been written, I want to know where we can get one of these wonderful engines? If any builder will offer to supply one, and guarantee its performance, I will undertake to recommend the administration of my railway to purchase it, on the conditions being fulfilled within six months after landing here. The builders should send with it an American engineman of good tough constitution for a tropical climate, as it is clear that he will have all his work cut out for him. Communications may be addressed to me through you, sir. The general conditions are as follows : Maximum wheel load, 4 tons (English) on rail ; ditto height, 11 ft. ; ditto width, $8\frac{1}{2}$ ft. ; ditto length, 35 ft. over all ; gauge, 3 ft. $3\frac{3}{8}$ in. (1 meter). For obvious reasons I do not sign my name at present, but prefer to remain,

An Indian Locomotive Superintendent.

To this letter the following answer has been sent, also addressed to the Editor of the *Engineer* :

Sir : In the *Engineer* of April 22 a correspondent, who signs himself "An Indian Locomotive Superintendent," challenges the assertion made in the Railroad and Engineering Journal that American locomotives, if put on Indian railroads, "would run 50 per cent. more miles in a given time and pull heavier loads," and says that he supposes he—the Editor of the Journal—"has some American locomotive builders at his back for whose benefit his articles have been written," and wants to know "where he can get one of these wonderful engines."

It is not entirely obvious what "having some locomotive builders at one's back" means. I may say, however, that the writer of the articles referred to has no interest whatever in any locomotive building establishment, excepting the little which results from the circumstance that some



VAUCLAIN COMPOUND FAST PASSENGER LOCOMOTIVE FOR THE PHILADELPHIA & READING RAILROAD.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS IN PHILADELPHIA.

of them advertise in his paper that they are prepared to do very excellent work. Furthermore, the articles referred to were not written with the knowledge, consent, or at the instigation or in the interest of any locomotive builders in this or any other country, excepting so far as the superiority of locomotives made either here or elsewhere was shown by the discussion.

Your correspondent gives the average mileage of locomotives on Indian railroads at 17,300 miles yearly. It was shown in the articles referred to—Table II, published last November—that the average annual mileage of nearly 15,000 locomotives in this country was 35,650 miles. Your correspondent inquires where he can get "one of these wonderful locomotives." In reply I will say that there are a half dozen or more reliable companies in this country who would furnish locomotives which they would guarantee to run an average of 36,000 miles per year under fair treatment and like conditions of traffic that prevail on our roads here; they would also guarantee that the engines would not be affected by the Indian climate, and that they could be run without disadvantage by different crews of competent men, so that the endurance of the men need not limit the number of miles run. Some or all of these builders would send competent men with the engines to see that they fulfilled the required guarantees.

If your correspondent will also furnish the requisite data concerning the grades, curves, speeds, or loads to be hauled, and quality of fuel and water used, the builders will also advise what type of locomotive should be used for the service, and would guarantee the loads they will haul, the speed at which they will run, and the amount of fuel they will consume, and would make the engines conform to the conditions given by your correspondent in his letter.

Furthermore, if he seriously contemplates, as he says he does, recommending the administration of his railroad to purchase an engine "on the conditions being fulfilled within six months after landing in India," I will take great pleasure in giving him any other information or advice in my power; and if he desires it, will ascertain the prices and conditions on which one or more locomotives can be furnished to his company, and will do this without any charge whatsoever to him, his company, or the builders of the locomotive.

M. N. FORNEY.

A FAST COMPOUND LOCOMOTIVE.

THE accompanying illustration is from a photograph of a compound locomotive recently built by the Baldwin Locomotive Works in Philadelphia for the Philadelphia & Reading Railroad. The general design will be seen from the engraving; the engine is carried on eight wheels, four coupled wheels placed close together under the boiler, a two-wheeled truck forward and a pair of bearing wheels under the fire-box. For fast work this makes a compact and easy running engine.

The work done by this engine has so far been very good. At the present time it is employed in running trains 503 and 512 of the Bound Brook Line between Jersey City and Philadelphia. On train 512 the distance of 85.1 miles between Wayne Junction and Jersey City is made in 98 minutes, or at an average speed of 52.1 miles per hour; there are no regular stops, but it is necessary to slow down at several junction and crossing points. On train 503 the time is not so fast, the 85.1 miles requiring 111 minutes, or an average of 46 miles an hour. On this trip, however, there are four regular stops, so that the time, making allowance for them, is, after all, nearly as good. This is done in regular daily work.

On May 13, the train drawn by this engine left Philadelphia 17 minutes late, owing to some delay between Baltimore and that city. Several stops are required before reaching Wayne Junction, but after passing that point the run was made at high speed. The entire distance—85.1 miles—from Wayne Junction to Jersey City was covered in 87 minutes, or at an average speed of 58.7 miles an hour. At one part of the run 10 miles were made in 7.55 minutes, or at the rate of 79.6 miles an hour. The train consisted of four heavy cars, and there was an adverse wind blowing.

The fire-box of this engine is of the Wootten pattern. The boiler barrel is 57½ in. in diameter, and contains 324 tubes 1¼ in. in diameter and 10 ft. long. The fire-box is 9 ft. 6 in. long and 8 ft. 0½ in. wide, the grate area being about 76 sq. ft. The heating surface is: Fire-box, 128.09 sq. ft.; combustion chamber, 45.37 sq. ft.; tubes, 1,261.75 sq. ft.; total, 1,435.21 sq. ft.

The engine is a compound, of the Vauclain four-cylinder type; the high-pressure cylinders are 13 in. and the low-pressure 22 in. in diameter, both being 24-in. stroke. The four driving-wheels are 6 ft. 6 in. in diameter, and the driving axles are only 6 ft. 10 in. between centers, making a very short parallel rod, an advantage at high speed. The driving wheel-base, as stated above, is 6 ft. 10 in.; the total wheel-base of the engine is 23 ft. 4 in.

The total weight of the engine in working order is 128,800 lbs., of which 82,800 lbs. are carried on the drivers.

The tender is carried on two four-wheeled trucks, and is of the usual pattern in use on the road. The tank has a capacity of 4,000 gallons of water.

NOTES FROM CHINA.

IN the January number of the JOURNAL the appointment of Mr. W. N. Pethick as Assistant Managing Director of the Imperial Railways of North China and the China Railway Company was noted. His authority has now been enlarged, and he has assumed joint control with the Managing Director of the financial business and accounts of those lines.

THE grading of the railroad from Tientsin to Shan-Hai-Kuan continues, and the rails were, at latest dates, expected to arrive from England soon.

THERE are rumors of the revival of the Viceroy Li Hung-Chang's original project of a railroad from Tientsin to Tung-chow, near Peking; but no definite announcement has yet been made.

JUST now the French are putting great pressure on the Chinese Government to force China to grant special privileges to France under Article 7 of the Franco-Chinese treaty of 1885. This article reads:

> When China on her part shall have decided to construct railroads, it is agreed that she shall have recourse to French industry, and the Government of the Republic shall afford every facility for procuring in France the staff that may be required. It is, moreover, understood that this clause shall not be looked upon as constituting an exclusive privilege in favor of France.

The Chinese originally allowed this clause to be inserted as an easy way of pleasing the French, but they never really meant anything by it. Recently, however, M. Lemaire, the French Minister at Peking, has formally complained to the Tsung-li Yamen—the Foreign Office—that China is not fulfilling the treaty. He maintains that the French accepted this concession in 1885 as an equivalent for a war indemnity, and threatens that, unless the Chinese favor France in the construction of railroads, the question of indemnity will be reopened. The Chinese Government has made a spirited reply, denying the claim made by France; but whether this resistance will be continued, or the Government will yield to pressure, is now doubtful.

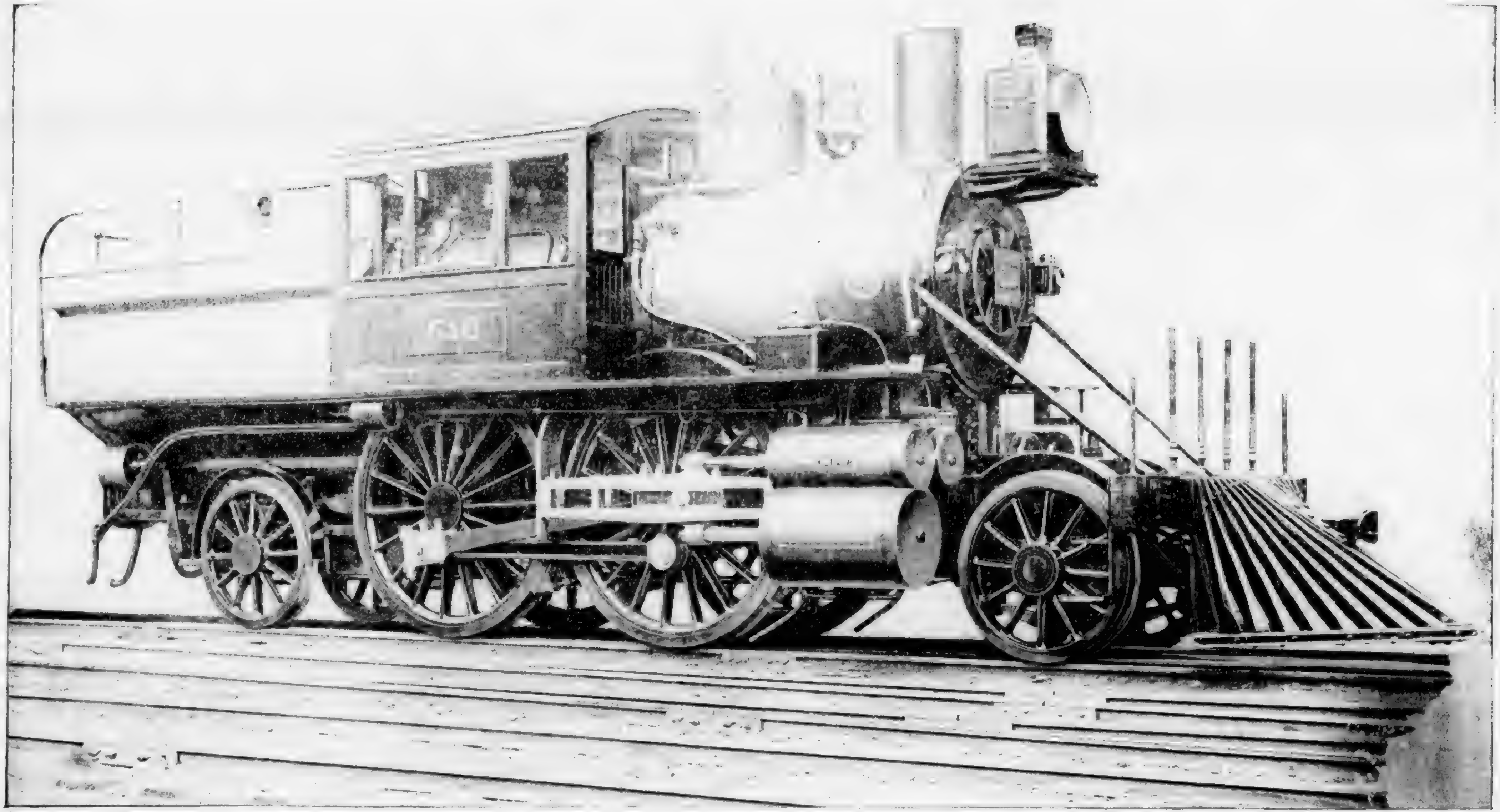
THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.*

BY A. ZDZIARSKI, C.E.

THE WESTERN SIBERIAN RAILROAD.

IN my first article on the Great Siberian Railroad (in the JOURNAL for June, 1890, page 258) I expressed the opinion, that the Great Siberian Railroad would be con-

* See RAILROAD AND ENGINEERING JOURNAL for June, September, November and December, 1890; January, February, March and July, 1891.



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of them advertise in his paper that they are prepared to do very excellent work. Furthermore, the articles referred to were not written with the knowledge, consent, or at the instigation or in the interest of any locomotive builders in this or any other country, excepting so far as the superiority of locomotives made either here or elsewhere was shown by the discussion.

Your correspondent gives the average mileage of locomotives on Indian railroads at 17,300 miles yearly. It was shown in the articles referred to—Table II, published last November—that the average annual mileage of nearly 15,000 locomotives in this country was 35,650 miles. Your correspondent inquires where he can get "one of these wonderful locomotives." In reply I will say that there are a half dozen or more reliable companies in this country who would furnish locomotives which they would guarantee to run an average of 36,000 miles per year under fair treatment and like conditions of traffic that prevail on our roads here; they would also guarantee that the engines would not be affected by the Indian climate, and that they could be run without disadvantage by different crews of competent men, so that the endurance of the men need not limit the number of miles run. Some or all of these builders would send competent men with the engines to see that they fulfilled the required guarantees.

If your correspondent will also furnish the requisite data concerning the grades, curves, speeds, or loads to be hauled, and quality of fuel and water used, the builders will also advise what type of locomotive should be used for the service, and would guarantee the loads they will haul, the speed at which they will run, and the amount of fuel they will consume, and would make the engines conform to the conditions given by your correspondent in his letter.

Furthermore, if he seriously contemplates, as he says he does, recommending the administration of his railroad to purchase an engine "on the conditions being fulfilled within six months after landing in India," I will take great pleasure in giving him any other information or advice in my power; and if he desires it, will ascertain the prices and conditions on which one or more locomotives can be furnished to his company, and will do this without any charge whatsoever to him, his company, or the builders of the locomotive.

M. N. FORNEY.

A FAST COMPOUND LOCOMOTIVE.

THE accompanying illustration is from a photograph of a compound locomotive recently built by the Baldwin Locomotive Works in Philadelphia for the Philadelphia & Reading Railroad. The general design will be seen from the engraving; the engine is carried on eight wheels, four coupled wheels placed close together under the boiler, a two-wheeled truck forward and a pair of bearing wheels under the fire-box. For fast work this makes a compact and easy running engine.

The work done by this engine has so far been very good. At the present time it is employed in running trains 503 and 512 of the Bound Brook Line between Jersey City and Philadelphia. On train 512 the distance of 85.1 miles between Wayne Junction and Jersey City is made in 98 minutes, or at an average speed of 52.1 miles per hour; there are no regular stops, but it is necessary to slow down at several junction and crossing points. On train 503 the time is not so fast, the 85.1 miles requiring 111 minutes, or an average of 46 miles an hour. On this trip, however, there are four regular stops, so that the time, making allowance for them, is, after all, nearly as good. This is done in regular daily work.

On May 13, the train drawn by this engine left Philadelphia 17 minutes late, owing to some delay between Baltimore and that city. Several stops are required before reaching Wayne Junction, but after passing that point the run was made at high speed. The entire distance—85.1 miles—from Wayne Junction to Jersey City was covered in 87 minutes, or at an average speed of 58.7 miles an hour. At one part of the run 10 miles were made in 7.55 minutes, or at the rate of 79.6 miles an hour. The train consisted of four heavy cars, and there was an adverse wind blowing.

The fire-box of this engine is of the Wootten pattern. The boiler barrel is 57½ in. in diameter, and contains 324 tubes 1¼ in. in diameter and 10 ft. long. The fire-box is 9 ft. 6 in. long and 8 ft. 0½ in. wide, the grate area being about 76 sq. ft. The heating surface is: Fire-box, 128.09 sq. ft.; combustion chamber, 45.37 sq. ft.; tubes, 1,261.75 sq. ft.; total, 1,435.21 sq. ft.

The engine is a compound, of the Vauclain four-cylinder type; the high-pressure cylinders are 13 in. and the low-pressure 22 in. in diameter, both being 24-in. stroke. The four driving-wheels are 6 ft. 6 in. in diameter, and the driving axles are only 6 ft. 10 in. between centers, making a very short parallel rod, an advantage at high speed. The driving wheel-base, as stated above, is 6 ft. 10 in.; the total wheel-base of the engine is 23 ft. 4 in.

The total weight of the engine in working order is 128,800 lbs., of which 82,800 lbs. are carried on the drivers.

The tender is carried on two four-wheeled trucks, and is of the usual pattern in use on the road. The tank has a capacity of 4,000 gallons of water.

NOTES FROM CHINA.

IN the January number of the JOURNAL the appointment of Mr. W. N. Pethick as Assistant Managing Director of the Imperial Railways of North China and the China Railway Company was noted. His authority has now been enlarged, and he has assumed joint control with the Managing Director of the financial business and accounts of those lines.

THE grading of the railroad from Tientsin to Shan-Hai Kuan continues, and the rails were, at latest dates, expected to arrive from England soon.

THERE are rumors of the revival of the Viceroy Li Hung-Chang's original project of a railroad from Tientsin to Tung-chow, near Peking; but no definite announcement has yet been made.

JUST now the French are putting great pressure on the Chinese Government to force China to grant special privileges to France under Article 7 of the Franco-Chinese treaty of 1885. This article reads:

> When China on her part shall have decided to construct railroads, it is agreed that she shall have recourse to French industry, and the Government of the Republic shall afford every facility for procuring in France the staff that may be required. It is, moreover, understood that this clause shall not be looked upon as constituting an exclusive privilege in favor of France.

The Chinese originally allowed this clause to be inserted as an easy way of pleasing the French, but they never really meant anything by it. Recently, however, M. Lemaire, the French Minister at Peking, has formally complained to the Tsung-li Yamen—the Foreign Office—that China is not fulfilling the treaty. He maintains that the French accepted this concession in 1885 as an equivalent for a war indemnity, and threatens that, unless the Chinese favor France in the construction of railroads, the question of indemnity will be reopened. The Chinese Government has made a spirited reply, denying the claim made by France; but whether this resistance will be continued, or the Government will yield to pressure, is now doubtful.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.*

BY A. ZDZIARSKI, C.E.

THE WESTERN SIBERIAN RAILROAD.

IN my first article on the Great Siberian Railroad (in the JOURNAL for June, 1890, page 258) I expressed the opinion, that the Great Siberian Railroad would be con-

* See RAILROAD AND ENGINEERING JOURNAL for June, September, November and December, 1890; January, February, March and July, 1891

structed as a continuous line connecting the European railroad system with the Amour settlements and the Pacific.

However, at that time this opinion had many adversaries, even in the Special Commission, appointed in order to fix the general location of the line; but now I am happy to state that my opinion has prevailed, for in February, 1891, the Committee of Ministers decided, and their decision was endorsed by the Emperor, that the surveys and location of the Western Siberian Railroad should be commenced from Chelabinsk, as a starting-point, and run to Tomsk or some other point of the Central Siberian Railroad already located. Chelabinsk is the terminus of the Zlatooust-Chelabinsk Railroad, now in construction, and described in the JOURNAL for November, 1890, page 503.

At the same time it was decided that the construction of the Great Siberian Railroad, already commenced at its eastern end on the Pacific Coast, should also begin from its western end, Chelabinsk, and on its western section, called the Western Siberian Railroad, which will be a continuation of the Samara-Oufa-Zlatooust Railroad, already opened, and of the Zlatooust-Chelabinsk line now in construction and to be opened in autumn, 1892.

Such decision was a consequence of the will of the Emperor, expressed in his rescript addressed to the Czarevitch, and made public on May 11/23, 1891, which stated that the Trans-Siberian Railroad shall be constructed as a continuous line.

According to the above the surveys of the Western Siberian Railroad should be so executed in the year 1891 as to furnish the definitive location, which shall be followed at once by construction. The cost of survey and location of about 1,000 miles was estimated to be 211,300 roubles, and the time required two years—1891 and 1892—for the location of the eastern section required more time, it being more difficult.

The surveys and location of the Western Siberian Railroad were so executed as to satisfy the following conditions:

1. That the main line be as short as possible and be designed with the smallest possible gradients and greatest radii of curves.

2. That it should go through the settled country and near the industrial centers or towns.

3. That the crossings of the rivers be convenient for navigation purposes and favorable for building of bridges.

4. That the construction of the railroad be as cheap as possible, which can be obtained by relaxing the specifications (technical conditions) in accordance with the requirements of locality and in view of a small traffic.

According to these conditions the line was *definitively* located from Chelabinsk to Kaïnsk (see the plan), 1,049 versts = 700 miles. The continuation of this line eastward could be made in two ways: One going directly to Tomsk with great technical difficulties, and the other going southward, through a less difficult country, to a connection with any point of the Central Siberian Railroad and including a branch to Tomsk. The choice of one of these lines will be made in this year (1892), but it is very probable that the southern line will prevail, as it is more economical in construction and more convenient for through traffic purposes.

The surveys of the year 1891 have given all the data necessary for the location and the estimates of the line from Chelabinsk to the Obi River, and for the approximate estimate of the remaining section of line from the Obi River to the junction with the Central Siberian line.

In the following paragraphs I give the results of the surveys made in the year 1891.

LOCATION AND LENGTH OF THE LINE.

The general location of the Western Siberan Railroad, from its starting-point—Chelabinsk—to the crossing of the River Obi, follows the parallel of the 55th degree of north latitude, with very small deviations, occasioned by the desire to draw near the towns, to meet more convenient places for crossing rivers or to avoid some obstacles. The greatest of these deviations bears only to a few minutes of latitude; the greatest northern deviation being 26′ (latitude being 55° 26′) for the crossing of the Obi River, and the greatest southern deviation 8′ (latitude being 54° 52′) near the city of Petropavlovsk. Straight lines, or tangents, dominate; there are 93.52 per cent. of straight lines and only 6.48 per cent. of curves. After crossing the Obi River the line deviates to the north and reaches its terminus on the Central Siberian Railroad in the latitude of 56° 9′.

The location of the line was not difficult, as is obvious from the following details. From the starting-point at Chelabinsk, the line follows an eastward direction, making some deviations in order to go round the lakes and marshes, till it reaches the River Tobol. After crossing this river near the city of Kourhan, the line rises over the divide between the Tobol and the Outiak, crosses the latter river and then follows an eastward direction up to the valley of the Ishim River. Having crossed this river near Petropavlovsk, the line rises over the divide between the Ishim and the Irtish, and then follows the almost level valley of the Kamishlov, an old tributary of the Irtish, now dry and presenting a series of bitter-salt lakes. After crossing this valley twice the line reaches the Irtish River, and crosses it 3 miles southward from the city of Omsk, at a point most convenient for a bridge or ferry.

After crossing the Irtish River the line enters the Baraba Steppe (plateau), such a level country that it was possible to locate there two straight lines or tangents, one 60 miles long and another 86 miles long. The first of these straight lines goes along the Omi River, a tributary of the Irtish, and the other is controlled by the general direction of the line to the city of Kaïnsk and the numerous lakes, which it meets before it reaches that city.

From Kaïnsk eastward the line still follows the valley of the Omi River, and then the divide between that river and the Chany Lake. After crossing this divide near the source of the Tandovka River, the line follows the southern slope of the divide, crosses the Kojourla River, goes along the Great and Small Karapouz rivers, then follows the divide between the Karapouz and the Kargat rivers, enters the most level part of the Baraba Steppe, touches the south limit of the Vasugan Tundra, and reaches the station of Chulim, 1,220 versts = 813 miles from Chelabinsk.

To this point the location is accepted as final.

From the Chulim station the further location will depend upon the point selected for the crossing of the Obi River.

This point of crossing the Obi will very probably be fixed near the village of Krivoshchekova (southward of Kolivan), and the corresponding location of the line directed northeastward, after crossing the divide between the rivers Obi and Tomi and the River Tomi near Taly, and being led through very difficult mountain country following the divide between the Kitat and Yaya rivers, will reach the station Pochitanka of the already located Central Siberian Railroad, 80 miles from Tomsk.

The main line, located as above, will be connected with the city of Tomsk by means of a branch line 79 versts = 52 miles long, which could be constructed with relaxed technical conditions.

The mathematical distance between Chelabinsk and the Obi River at Krivoshchekova is 1,290.57 versts, the length of the line 1,324.41 versts; the difference is 33.84 versts, or 2.8 per cent. only.

The total length of the located Western Siberian Railroad, from Chelabinsk to Pochitanka, a station of the Central Siberian Railroad, is 1,620.07 versts = 1,080 miles.

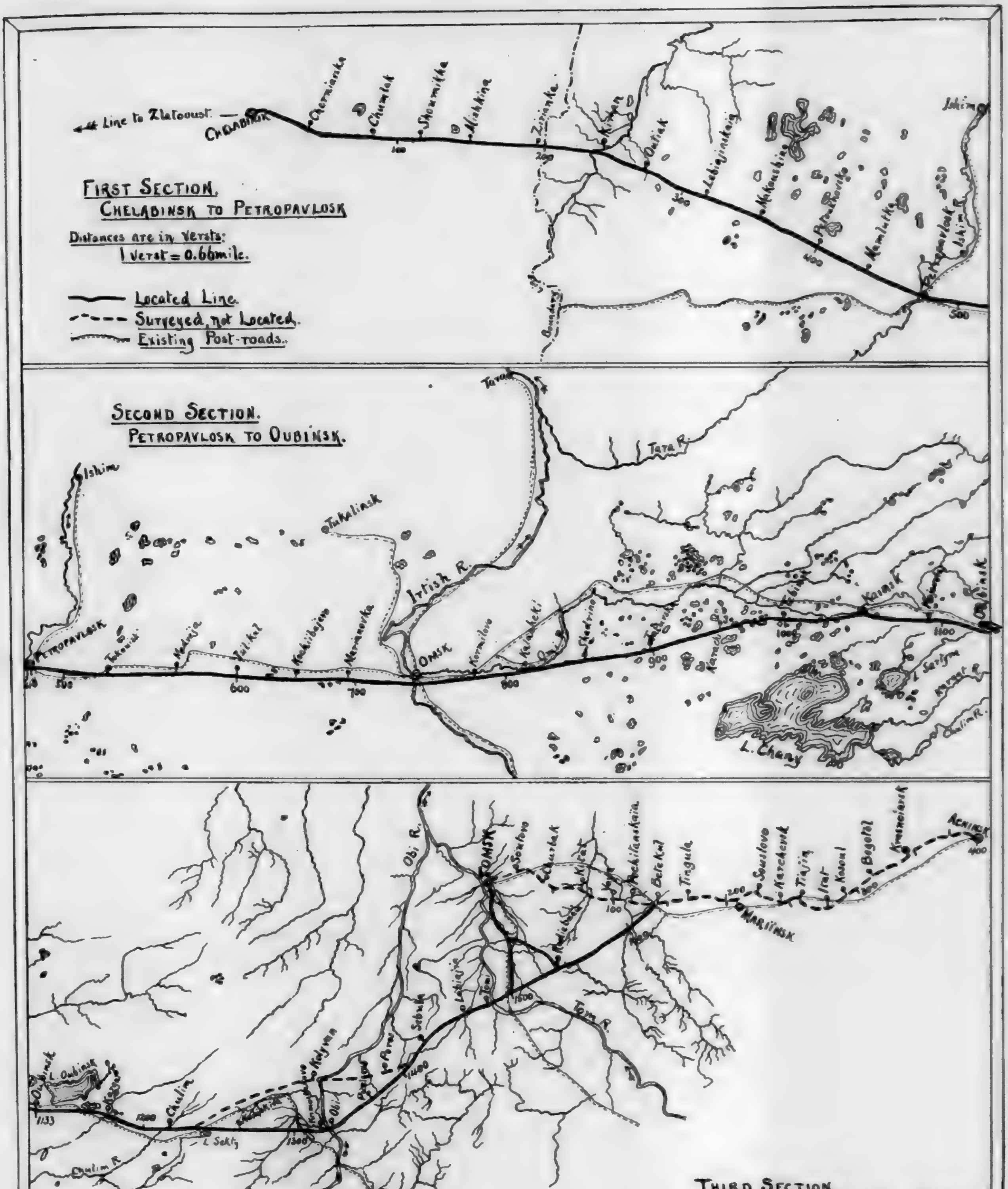
TOPOGRAPHY, CLIMATE AND POPULATION.

In consequence of the varying character of the country the above located line must be divided into two divisions, as follows:

I. From Chelabinsk to the Obi River 1,324 versts = 883 miles.

II. From the Obi River to Pochitanka 296 versts = 197 miles.

The first section (from Chelabinsk to the Obi River) is a level plateau cut by three great rivers: the Tobol, the Ishim and the Irtish. The ground is so level as to be almost ready for track-laying; only the crossing of the great rivers will require heavy earthworks. The soil is



LOCATION OF THE WESTERN SIBERIAN RAILROAD.

generally fertile ; the climate is favorable for agriculture, which could be largely developed.

According to the quality of the soil and the quantity and quality of water, this division can be subdivided into three sections :

1. From Chelabinsk to the Ishim River, where the soil is fertile and consists of vegetable earth with clay subsoil, there are many lakes and small birch woods, and the production of crops is great.

2. Between the Ishim and the Irtish rivers, where the soil is partly salt marsh, partly fertile ; the lakes have bitter-salt water, good water occurs seldom, and the chief occupation of the inhabitants is the breeding of cattle.

3. Between the Irtish and the Obi rivers, where the country is covered with a quantity of salt and sweet lakes, marshes and birch woods, and the soil presents good clay earth and partly salt earth.

The second division, from the Obi to Pochitanka, is a mountain country covered with untouched forests (taïga), with abundant springs and small rivers ; here the location was very difficult.

The climate along the line of the Western Siberian Rail-

road is very severe; the summer is very short and warm, the winter very long. The mean temperature of winter in Chelabinsk is — 17° C. (1.4° F.); between Omsk and Lake Baïkal — 19° and — 22° C. (— 2.2° and — 7.6° F.); often the minimum temperature reaches — 40° C. (— 40° F.), the freezing point of mercury, and even — 50° (— 58° F.) in Tomsk. The daily variation of temperature of 25° C. (45° F.) occurs often, and in the steppes there occur heavy snow-storms combined with southerly, southeasterly and easterly winds.

The population is very thin, about two men per square verst; it is 10 times thinner than in European Russia.

DETAILS OF DESIGNED CONSTRUCTION.

The Western Siberian Railroad is designed according to the relaxed technical conditions, elaborated by the Direction of State Railroads and endorsed by the Minister of Roads and Communications in 1887.

Of course the light topography of the country has not required the application of these relaxations concerning the limiting gradients and curvatures, so that the principal relaxations were the following:

1. The width of grade was generally admitted to be 16.45 ft., except in marshy soil and on high embankments subject to shrinkage, where it will be 18.2 ft.; the slope is allowed to be 1½.

2. The bridges may be of wood, except over great rivers; cast-iron culverts are allowed.

3. The thickness of ballast was fixed at 12½ in. under the foot of rails; the rails of a very light type, the weight being 54 lbs. Russian (49 lbs. English) to the yard.

4. The line buildings will not be numerous and will be of very simple type; the road crossings are allowed to be unprotected.

5. The distance between stations (sidings) was allowed to be 50 versts = 33 miles; the passenger buildings of very simple description, according to local conditions of traffic, and freight sheds only required in great industrial centers.

6. The distance between water supplies was allowed to be the same—33 miles—and the water supply to be made by means of the pulsometer.

7. The rolling stock supplied will be sufficient for two trains (a mixed and a freight train) daily in each direction.

(TO BE CONTINUED.)

THE MARGHERITA BRIDGE AT ROME.

(From *Industries.*)

In 1881 a law was passed by the Italian Government for enforcing the construction of at least two bridges over the Tiber, at Rome, by the city authorities. One of these, called the Garibaldi Bridge, was completed in 1888, and the other, called the Margherita Bridge, which is the subject of this article, was opened to the public in December last. Fig. 1 shows a general elevation of the bridge; fig. 2 a transverse section, and fig. 3 a half plan. The bridge is a handsome and substantial structure.

The foundations were made with large compressed air caissons, 100 ft. × 46 ft. 6 in. The depth of the foundations was intended to be 43 ft., but was afterward increased to about 52 ft. below the low-water level of the river. The foundation work has been carried out by the Société of Fives-Lille at a cost of $399,500. The superstructural work, including the piers and arches, has been done by Messrs. Allegri, Lazzeri & Company, of Florence, in a little over two years, at a cost of $232,300.

This is one of the largest bridges in Rome, and there are few that can compete with it for boldness of design, elegance of outline, and accuracy of execution. The arches of the bridge are polycentral, with five centers, their shape being approximately a half ellipse. Each arch is of 99 ft. chord and about 16 ft. 6 in. pitch, with a height from the foundation of 75 ft. 4 in. The tops of the piers on which the arches are based are about 17 ft. 9 in. above the upper surface of the foundations and 21 ft. above low-water. The roadway is about 370 ft. long by 67 ft. 6 in. wide at the narrowest point.

The strength of the principal materials used in this bridge is as follows: Stone of Rezzato, 1,500 kilos. per square centimeter; Travertino, 900 kilos.; bricks, 180 kilos.; cement, 38 kilos. The tests were made with Michaelis' machine, and the figures given above represent an average of 950 tests made.

This bridge, along with the Garibaldi Bridge, was designed by Signor Angelo Vescovali, Chief Engineer to the hydraulic service of the city of Rome, who has also designed two for the suburbs.

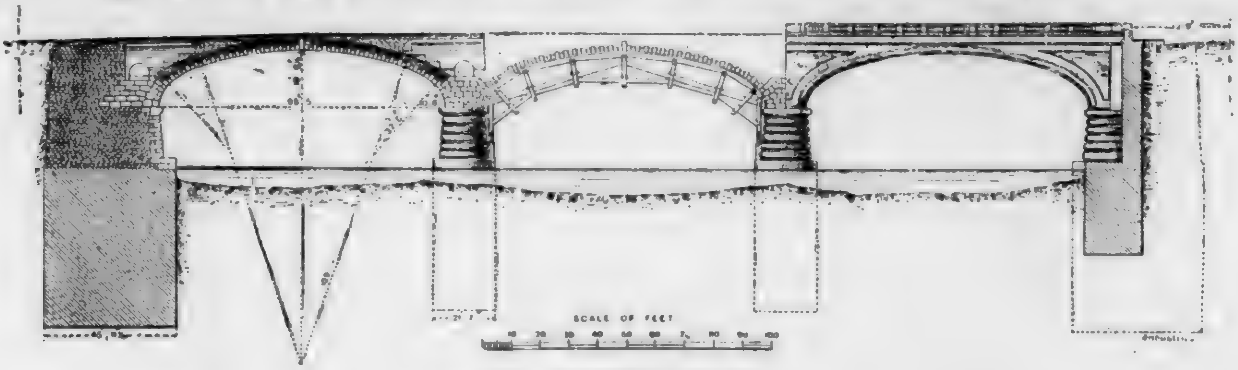


FIG. 1.—PART-SECTIONAL ELEVATION.

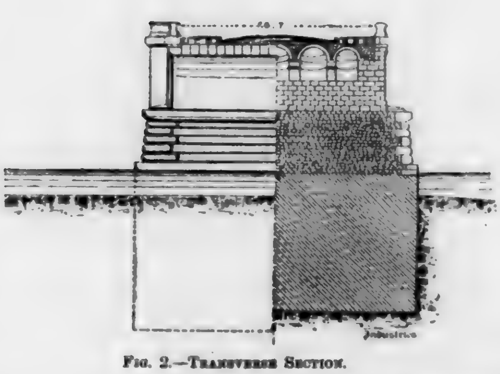


FIG. 2.—TRANSVERSE SECTION.

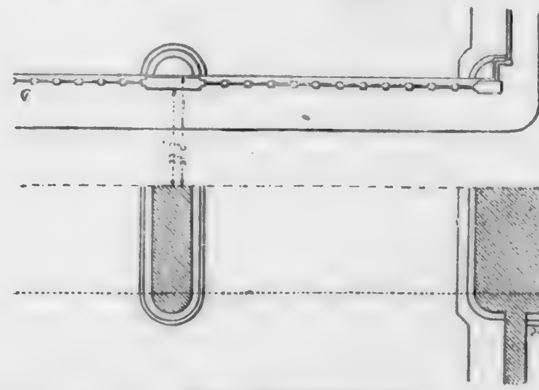


FIG. 3.—PART-SECTIONAL PLAN.

THE MARGHERITA BRIDGE AT ROME.

AN EARLY DESIGN FOR A COMPOUND LOCOMOTIVE.

To a long and carefully written report on the Compound Locomotive, made by the Committee on Science and the Arts to the Franklin Institute of Philadelphia, and published in the *Journal* of the Institute, we are indebted for the accompanying engravings, which show an early design for a compound locomotive. It is not stated, however, that a locomotive was ever built from these plans, although a stationary engine was apparently built by the inventor. The designs were given in a book called "The Chemistry of the Steam Engine," by Thomas Craddock, published in London in 1847. His engine was a condensing engine, in which air instead of water was used in the condenser. The report says:

In the month of April and year 1844, Mr. Craddock made experiments with a compound engine of his own designing, which he says is "the *first* engine ever constructed on the principles I am here treating of, which are those of condensing by *air* with the production of a *vacuum*."

The extent of the vacuum obtained by these means—a revolving fan-wheel—was 18 in.

"On the application of the invention under discussion to locomotive engines, I have thought much, as we had at one time determined on constructing a locomotive upon the principles I have set forth. . . .

"The best mode, as it appears to me, of applying these principles for locomotive purposes, would be to construct a tubular boiler, having several ranges of tubes. . . . I should also propose that, to insure the most economical use of the steam, the *twin cylinders*, of which I have before spoken, be fixed much in the same way as the cylinders are at present. We should then have a combination of the high- and low-pressure engine moving itself and a train along our railway. . . . Another thing to be desired, which would result from such locomotives as I am here speaking of (with air condensation and return of condensed steam to the boiler again) is, that we should have no noise from, or even *appearance* of steam."

Mr. Craddock further states that, with his twin engine

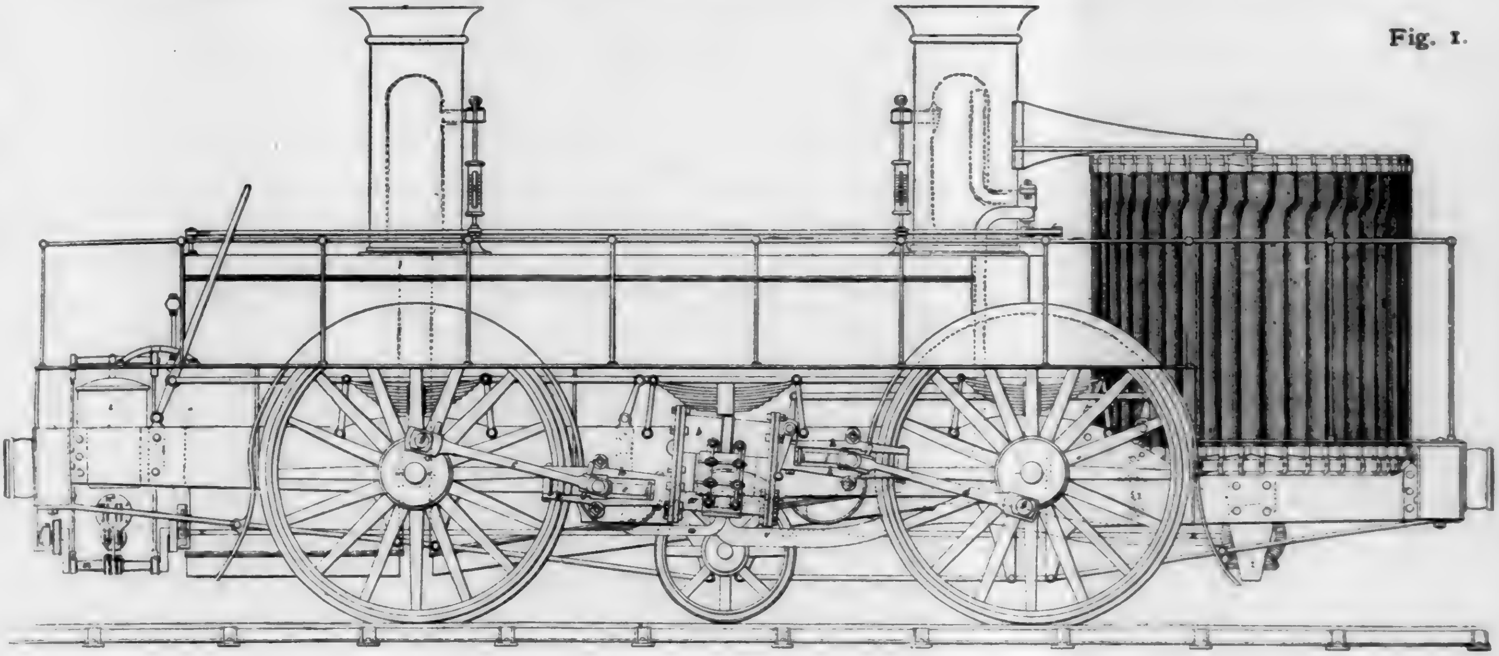


Fig. 1.

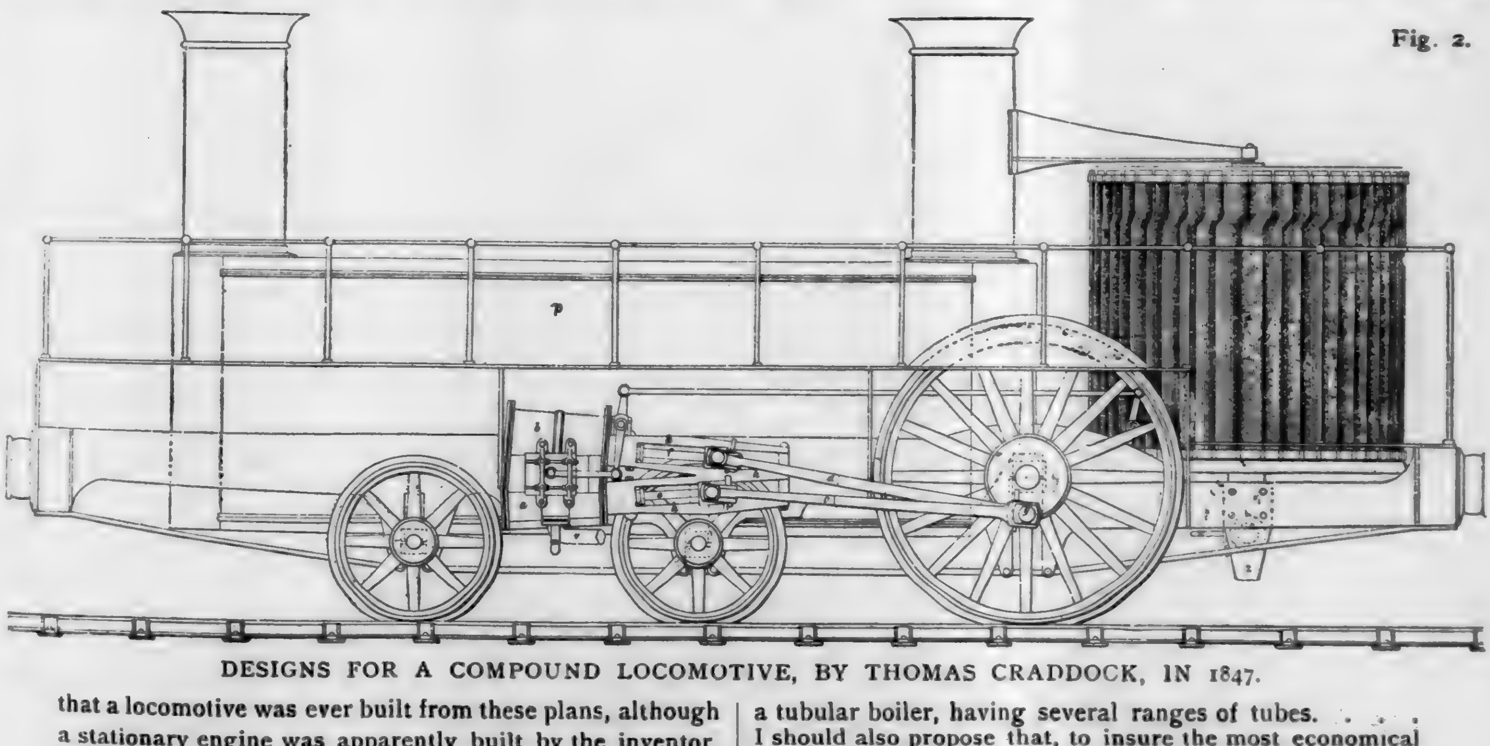


Fig. 2.

DESIGNS FOR A COMPOUND LOCOMOTIVE, BY THOMAS CRADDOCK, IN 1847.

of 6-in. and 14-in. cylinders combined with his air condenser, by which he obtained a 24-in. vacuum, thus realizing his anticipations, he also performed a double quantity of work with the same quantity of steam. "I have fixed upon 115 lbs. as the pressure of steam in the boiler, because that is the pressure I have used. But many years will not pass before 200 lbs. pressure per square inch will be used, and this with almost total exemption from danger."

Mr. Craddock's patent universal condensing steam engine bears date December 3, 1846, and embodies a claim for the adaptation of double-cylinder engines, attached to separate cranks, to railroad locomotives, and a claim for the adaptation of the angularly-set double-cylinder engine, attached to a single crank, to railroad locomotives. He further says more specifically, "I claim, in relation to all that class of high-pressure engines in which steam of a high pressure is used in one small cylinder, and then expanded into a second and larger cylinder, the setting of the cylinders at an angle and connecting them to one crank-pin, whether combined or not combined with my other improvements, all or any of them, and in whatever position the said cylinders may be fixed in other respects, as horizontally, vertically or obliquely."

Mr. Craddock's book, published in London in 1847, giving full descriptions of his engines, is illustrated by 10 large folding plates of general and detailed views, well and handsomely executed. Three of these plates represent railroad locomotives, with two cylinders, a high- and a low-pressure on each side of each engine. In one of them (fig. 1), with parallel-located cylinders, each cylinder is connected to a crank of its own—two to a forward and two to a backward driving axle; in the other (fig. 2), both cylinders on each side, angularly set, so that the axis of each passes through the center of the driving axle, connect to one crank and to one driving axle; the former having four driving wheels and the latter two, no side rods on either. Illustrations of both these types of construction are given herewith, which sufficiently explain themselves.

Mr. Craddock proposed to produce steam without blast by increasing the grate surface to make up for this loss; he would thus secure a quiet running and clean engine. He condensed all the exhaust steam in an enclosed air fan-wheel, returning all the water of condensation back to the boiler for reconversion into steam. He used tubular boilers, which afford thin metal, with large extent of surface, supplied pure water to the boiler, and thus avoided deposit, condensed the steam, thus availing himself of the benefit of expansion at the *best* end of it.

The locomotive cylinders have a diameter ratio of 4 : 10 with stroke of 12; driver diameter of 52 and gauge of rails 55½. (No scale on drawings.)

Mr. Craddock certainly conceived many happy engine thoughts, and published much data having creditable simplicity, well worth our study. His theories and principles of construction are well marked with many lines of perfection, and considering date and conditions, his eight years and more of daily experimentation, fraught as they are with results, deserve well of our praise.

This design of Mr. Craddock's is earlier than that of John Nicholson (1850) or of James Samuel, which is of the same date. Mr. Samuel referred to the continuous expansion or compound system for locomotives in a paper published in 1852, which has been frequently quoted.

THE UNITED STATES NAVY.

It is probable that the battle-ship *Texas* will be launched at the Norfolk Navy Yard on July 4. Work on the *Texas* is now well advanced, and the ship is nearly ready, being in fact much further forward than the *Maine* when she was launched.

LAUNCH OF THE PRACTICE CRUISER.

The practice cruiser *Bancroft* was successfully launched from the yard of the S. L. Moore & Sons Company, at Elizabeth, N. J., on April 30, being the first war-ship built in that yard. The *Bancroft* is to be especially attached to the Naval Academy at Annapolis.

Peculiar difficulties attended the designing of this ship, which is intended to have, as far as possible, all the main features of a modern war-ship on a very limited displacement, and to be supplied with all the varied appliances necessary to give the naval cadets full training in the management of the latest type of vessels.

The vessel is a twin-screw steel cruiser, with the chief dimensions as follows: Length between perpendiculars, 180 ft.; length on water-line, 187 ft. 6 in.; extreme breadth, 32 ft.; mean draft, 11 ft. 6 in.; displacement, 838 tons.

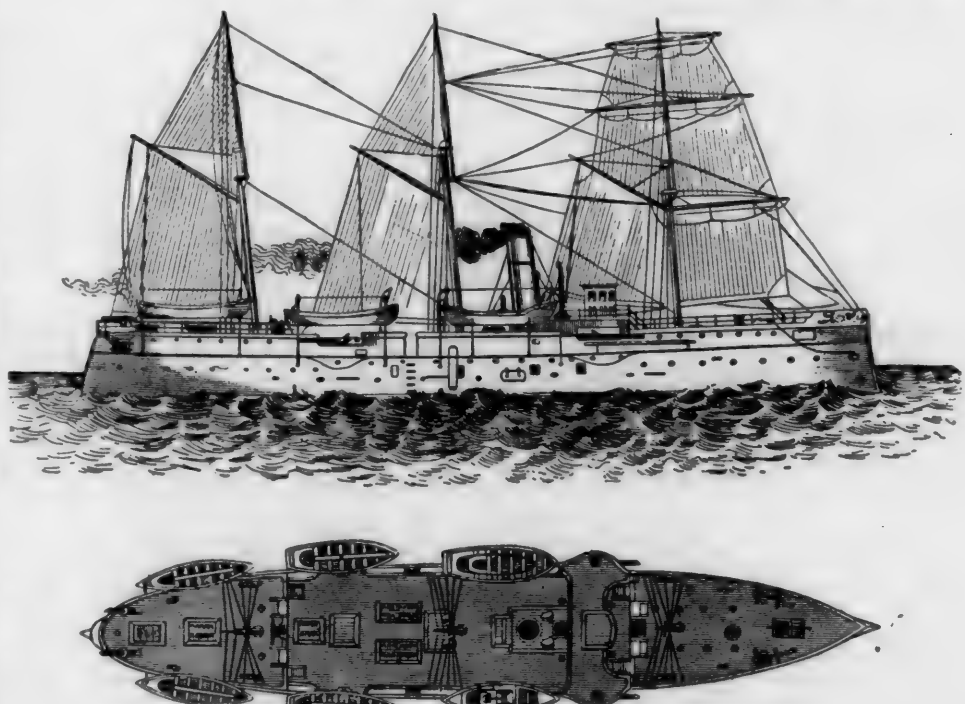
Unlike some of the other cruisers, she is provided with considerable sail power. The rig is that of barkentine, the sail area being about 5,000 sq. ft.

The armament consists of four 4-in. rapid-fire rifled guns, mounted on central pivots and protected by steel shields; three 6-pdr., two 3-pdr., and one 1-pdr. rapid-fire cannon; one 37-mm. revolving cannon, one Gatling gun, and two torpedo-tubes, one above water, and one bow launching tube.

There will be a full electric plant, steam-steering gear, and other appliances. Quarters are provided for captain eight officers and 120 cadets and seamen.

The engines, one for each screw, are of the direct-acting, vertical, inverted, triple-expansion type, with cylinders 13½ in., 21 in. and 31 in. in diameter and 20 in. stroke. There are two boilers, each 8 ft. 8 in. in diameter and 17 ft. long, with two corrugated furnaces 39 in. in diameter.

The coal capacity is 140 tons on normal draft. With this supply the radius of action is 1,560 knots at 13 knots an hour; 2,400 knots at 10 knots an hour, or 3,850 knots at 8 knots an hour.



PRACTICE CRUISER "BANCROFT," UNITED STATES NAVY.

LAUNCH OF THE "CASTINE."

THE gunboat *Castine* was launched from the yard of the Bath Iron Works, Bath, Me., May 11. She is a sister ship to the *Machias*, built at the same place, which was described in the JOURNAL for January. For convenience it may be repeated here that she is an unarmored steel ship 190 ft. long, 32 ft. beam, 12 ft. mean draft and 1,050 tons displacement. She has twin screws, each driven by a triple-expansion engine, with cylinders 15 in., 25 in. and 34 in. in diameter and 24 in. stroke. The speed is expected to be 14 knots, and the cruising range at a 10-knot speed about 4,700 knots.

The *Castine* will carry eight 4-in. rapid-fire guns and a secondary battery of four 6-pdr. and two 1-pdr. rapid-fire and two Gatling guns. She will have two masts, with fore-and-aft rig, and a considerable spread of canvas.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXVII.—SAMPLING; AND THE ENFORCEMENT OF SPECIFICATIONS.—(*Concluded.*)

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 211.*)

IN making our test reports we use a blank, copy of which is given below. It will be observed that this blank gives the date, specifies the shop for which the material is to be furnished, describes the material, states when it was received, who from, on what requisition number, and at what price. This information is furnished by the tag which accompanies the sample from the shop. It will also be observed that there is a space left on the blank to give the analysis. It has been our custom many years to give the figures of the analysis. We do this for two reasons. First, as a means of instructions to those who use the reports, since universal experience seems to show that the more a man knows about the materials he is dealing with, the more efficient he will be. Second, in case of dispute the manufacturers have a right to know the results of our tests, and, as will be explained a little farther on, the test report ultimately goes to the Purchasing Agent, and by him can be shown, if necessary, to the manufacturer whose material is condemned. It will be observed that there are two blanks, both bearing the same number and differing in the wording at the bottom of the blank. In one case, where the material is ready for use, this sentence is printed in, and it is necessary only to sign the name at the bottom. In the other case, where the material does not fill specifications, the blank is left open so that the recommendation to return, and the reasons why, can be written in in ink. On the back of the blank is given the proper nomenclature for the record and also a synopsis of the specifications. This synopsis is given so that in case of dispute, it will not be necessary to get out the specifications, but simply turn the test report over and see what the essential points of the specifications are. This information is for the use of the Purchasing Agent and those with whom he is brought in contact over rejected materials. The following are the blanks:

M. P. 233.

PENNSYLVANIA RAILROAD COMPANY.

MOTIVE POWER DEPARTMENT.

REPORT OF TESTS.

Altoona, Pa.,.............18....

At *Shops, Sample of*

received *from*

on requisition *at*

test as follows:

This is according to specifications, and material is ready for use.

........................*Chemist.*

M. P. 233.

PENNSYLVANIA RAILROAD COMPANY.

MOTIVE POWER DEPARTMENT.

REPORT OF TESTS.

Altoona, Pa.,.............18....

At *Shops, Sample of*

received *from*

on requisition *at*

test as follows:

........................*Chemist.*

(BACK OF BLANK.)

No.....................

Material,..

Received,..

From..

Order No.........................

Form "C," No...........................

Passed..

SYNOPSIS OF SPECIFICATIONS.

Blue Vitriol.—Not over ¼ per cent. crystalized sulphate of iron, nor more than ½ per cent. of all other impurities. Contain nothing that will go through $\frac{3}{16}$ in. mesh sieve, and will not go through 1¼ in. mesh sieve.

Cabin Car Color.—Always purchased dry. No adulterant. Not less than 57 per cent. or more than 60 per cent. normal lead chromate. Not less than 38 per cent. or more than 42 per cent. lead oxide. Must not vary from standard shade.

Caustic Soda, or Concentrated Lye.—Bought by the pound, in half-pound or pound boxes, and in drums or barrels. Solid or granulated as ordered. Sample represents shipment, and only caustic soda ($NaOH$) paid for. Material must contain not less than 90 per cent. $NaOH$.

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs; No. XXV, in the February number, on Bearing Metals; No. XXVI., in the April number, on How to Make Specifications.

Detergent for Cleaning Paint and Varnish.—Mixture of powdered soap and tripoli or pumice; the tripoli or pumice not less than 65 per cent., or more than 75 per cent.; not more than 0.10 per cent. carbonate soda; 0.20 per cent. caustic soda; 0.30 per cent. common salt, or 5.00 per cent. water. No other substances than soap and tripoli or pulverized pumice. Must not scratch varnish.

Disinfectant.—Not less than eight fluid ounces per bottle, and not less than 20 per cent. zinc, 1 per cent. copper, 23 per cent. chlorine, and 0.14 per cent. mercury by weight. Shipments in barrels must show not less than 15.8 per cent. zinc, 0.8 per cent. copper, 0.13 per cent. mercury, and 18 per cent. chlorine.

Freight Car Color.—Bought in paste form, and paste must contain nothing but oil, pigment, and moisture, must not have over 2 per cent. volatile matter, and must not be a liver when received. Oil must be pure raw linseed, and must not be less than 23 per cent. or more than 27 per cent. of the paste. Pigment must have sulphate of lime fully hydrated, must contain no barytes, organic coloring matters, caustic substances, not less than 2 per cent. nor more than 5 per cent. carbonate of lime, not less than 40 per cent. sesquioxide of iron, and no inert material less opaque than sulphate of lime. Must conform to standard shade, and must pass test for fine grinding.

Locomotive Spring Steel.—Must be free from physical defects. Must not vary more than .01 in. in thickness, and 0.02 in. in width from size ordered. Not less than 0.90 per cent., or more than 1.10 per cent. carbon; not more than 0.50 per cent. manganese, 0.05 per cent. phosphorus, 0.25 per cent. silicon, 0.05 per cent. sulphur, 0.05 per cent. copper.

Mineral Wool.—Samples from three bags to be tested. Average weight of three samples not over 15 lbs. per cubic foot.

Oil—Extra Lard.—No other oils; not more free acid than is neutralized by 4 c. c. standard alkali, and must pass nitrate of silver test. From October 1 to May 1, cold test not over 45° F.

Oil—Extra No. 1 Lard.—No other oils; not more free acid than is neutralized by 30 c. c. standard alkali. From October 1 to May 1, cold test not over 45° F.

Oil—Neatsfoot.—No other oils; not over 15 per cent. free acid. From November 1 to April 1, cold test not over 45° F.

Oil—Tallow.—No other oils; not over 15 per cent. free acid. From November 1 to April 1, cold test not over 45°.

Oil—150° *Burning.*—Must not flash below 130°, nor burn below 151°. Color, "water white." No glue or suspended matter. Must not show cloud at 0° Fahrenheit for 10 minutes.

Oil—300° *Burning.*—Must not flash below 249°, nor burn below 298°. Color, "water white." No glue or suspended matter. Must not show cloud at 32° Fahrenheit for 10 minutes.

Oil—Paraffine.—Gravity, 24° to 29° Baume. Flash not below 249° Fahrenheit. Red or amber in color. Viscosity not less than 40 or more than 65 seconds. Cold test not above 10° Fahrenheit from October 1 to May 1.

Oil—Well.—Gravity, about 29° Baume. May 1 to October 1, flash not below 249°. October 1 to May 1, flash not below 200°. Cold test not above 10° F. from October 1 to May 1. No precipitation with gasoline. Viscosity not less than 55 or more than 100 seconds.

Oil 500°.—Straight petroleum; flash not below 445° Fahrenheit. No precipitation with gasoline.

Phosphor-Bronze Bearing Metal.—Bought in lots of 20,000 lbs. Inspected and weighed at place of manufacture. Mixed borings from three half pigs must show not less than 9 per cent. or over 11 per cent. of tin, not less than 8 per cent. or over 11 per cent. lead, not less than 0.70 per cent. or over 1 per cent. phosphorus, and all other substances than copper, tin, lead, and phosphorus in no greater amount than 0.50 per cent.

Sal Ammoniac.—Must be granulated or in pieces not larger than a wheat kernel. Not less than 65.15 per cent. of chlorine. Not less than 31.20 per cent. of ammonia (NH_3).

Soap—Common.—Bought by weight. Bars about one (1) lb. Not over ½ per cent. caustic soda, ½ per cent. carbonate soda, ½ per cent. mineral matter, and 1 per cent. common salt. 525 grains soda (N a 2 O)= one (1) lb. soap. Cylinder of soap ⅞ in. diameter and 1 in. long must hold up 5 lbs. five minutes, with not over $\frac{1}{16}$ in. compression.

Soap—Toilet.—Bought by weight. Cakes about ¼ lb. Not over ½ per cent. caustic soda, ½ per cent. carbonate soda, ½ per cent. mineral matter, 1 per cent. common salt. 630 grains soda (N a 2 O) = one (1) lb. soap. Glycerine and sugar paid for. 5 grains glycerine or 20 grains sugar equal 1 grain soda. Cylinder of soap ⅞ in. diameter, 1 in. long must sustain 15 lbs. five minutes without crushing or compressing more than $\frac{1}{16}$ in.

Springs—Helical.—Not less than 0.90 per cent. carbon, and not over 0.50 per cent. manganese.

Tallow.—Free from dirt or cracklings. Not more free acid than is neutralized by three (3) cubic centimeters, standard alkali. No soap or other foreign substance.

Tuscan Red.—Bought in paste form, and paste must contain nothing but pigment, oil, turpentine, and moisture. Paste must show not less than 74 per cent. of pigment, nor less than 8 per cent. of oil, and not more than 5 per cent. of moisture, or more oil than one-seventh of the weight of the pigment. Oil must be pure raw linseed oil, and turpentine of good quality. Pigment must contain not less than 75 per cent. sesquioxide of iron, not less than 2 per cent. or more than 5 per cent. carbonate of lime, and no barytes, or caustic substances, or organic coloring matter that has not been approved. Must conform to standard shade and pass test for fine grinding.

Wood Preservative.—Product of the distillation of Georgia pine. Must not flash below 172° Fahrenheit, burn not below 200° Fahrenheit, have a gravity less than 1.03, have more than 12.00 per cent. tar, or less than 30.00 per cent. tar acids. Must run freely at 20° Fahrenheit.

Zinc or Spelter.—Not more than ½ per cent. lead, nor more than $\frac{1}{10}$ per cent. of any other substance except zinc.

In case material fills all the requirements of the specifications, there is nothing requisite except for the officer who receives the bill to pin the test report to the bill, to sign the bill, and forward it in the regular way for payment, sending word at the same time to the shops that the material may be used. No bill for materials for which we have specifications is paid without the test report attached, and this portion of the service is very efficient, so far as we are able to determine. If the material does not fill the specifications, the test report says so, recommends the return, and tells why. This test report goes through the offices to the officer who has the bill, he immediately pins the test report to the bill, and returns the bill which goes in the regular way to the Purchasing Agent with a request to arrange for the return. Word is also sent to the shop ordering the material not to be used, but to be held subject to orders. In process of time the material is sent back to the party from whom it was purchased, with the usual requirement that he pay the return freight. It is customary for the manufacturers to be allowed a second opportunity to fill the requirements of the specifications on the same order. It sometimes happens, however, that the order is cancelled and placed with other parties.

It is always an objection to have to return a shipment, as it disarranges the work of the shops, and many times makes it necessary to supply that shop with material from some other portion of the road until the material can be replaced. This has led the Purchasing Agent to keep a record of those who fail to fill the specifications, and if the general habit of any manufacturer is to fail he soon loses all orders. From our own standpoint the temptation always is to accept a shipment rather than to reject, and if there is any bending or wavering or yielding in the specifications, it is always in favor of the manufacturers, as from the reasons already given we do not like to reject shipments unless we are compelled to.

A very interesting feature of our experience in the matter of rejected shipments has been, that if some peculiarities of the specifications are ignored, and material accepted which does not quite fill the requirements, the manufacturers soon learn to take advantage of this, and every shipment that comes has this peculiarity. There is nothing so good to make shipments come up to specifications as an occasional rejection, and the more rigid the rejection the better the shipments which follow.

It will, of course, be understood that emergencies in the service may arise of such a nature that it would be absolutely essential to use inferior materials that do not fill specifications, and it would also naturally be understood, at least by those who are conversant with railroad affairs, that the Laboratory would not be a good judge of these emergencies, since it does not know at all the shops how much material is on hand. Accordingly each Superintendent of Motive Power is armed with a discretionary power to use a shipment of material, even though it does not fill the specifications, provided the emergency demands it. From his position he knows the condition in which each of the shops are as to supplies, and as the movement of trains depends on the supplies, notably so in the matter of oils, he must either use a condemned shipment sometimes, or else supply the shop from some other place. As the result of this discretionary power it sometimes happens that condemned materials which do not fill specifications

are used, and some manufacturers have deceived themselves into thinking our specifications were not enforced, knowing that inferior materials had been sent and that they had not been returned. It is not at all certain that the Railroad Company does not know that the materials are inferior and do not fill specifications because they are not returned. Emergencies are constantly arising which make it requisite to use inferior materials. The remedy comes, however, a little later in the loss of orders from the Purchasing Agent, as has been above described, since the Purchasing Agent is informed from month to month, in a report duly made for the purpose, of all materials that fail to fill specifications. It is fair to say that in general these emergencies which call for the use of condemned materials are few in number, and that by far the largest number of the condemned shipments are duly returned and replaced with good materials.

It is more than probable that the query will arise, at least among those who are conversant with the uncertainties of chemical methods, as to how these uncertainties are provided for in our methods. For example, it is well known that ordinary testing machines are not accurate to possibly within 500 lbs., or, again, it is well known that certain chemical methods do not give accurate results to within a small fraction of one per cent. The question arises, therefore, who shall have the benefit of this doubt, due to the uncertainties of the method? If a shipment of phosphor-bronze shows 11.10 per cent. of tin, this would be above the limit of our specifications, but the method of determining the tin may have not given accurate results to the extent of 0.10 per cent., and, as stated above, the query arises, whether the Company shall take this uncertainty or whether the manufacturer must meet this uncertainty? This question is not quite satisfactorily settled yet. We are inclined to think that the limits of our specifications are so wide, that if a manufacturer knows what he is doing, and aims between the extremes of our limits, he will never have a rejection due to getting outside the limits, even though the uncertainty of the method is construed against him. On the other hand, our experience now for many years has shown that very few manufacturers, especially outside the steel trade, know well what they are doing. Few of them have chemists and most of them work by rule of thumb, and many of them make the mistake of aiming at the limit which will just pass, so that it not infrequently happens we have been compelled to take the uncertainty of the analysis upon ourselves or else reject shipments. We are inclined to think it is immaterial which way the thing is adjusted, as if the manufacturer assumes the uncertainty of the method we would make a little broader limits in our specifications than if we have to assume the uncertainty of the method ourselves. In either case the limits are wide enough, we think, if any manufacturer understands his business, and one of the peculiar results of our specifications has been, that the trade of the Pennsylvania Railroad Company has necessarily drifted into the hands of those parties who are best informed in their own business, since they give us less trouble in the filling of specifications.

Several methods have been proposed to overcome the difficulty of having to return shipments which do not fill specifications. It is well recognized that many of the limits of our specifications are commercial, and that it would be impossible to detect in the service whether the material exactly filled specifications or came a little short. Of course, on the one hand, the efficiency of the specifications, and the certainty of getting good material in the future, depends on their enforcement. On the other hand, as has already been explained, the temptation constantly is to accept and use inferior materials, owing to the annoyance that arises from their return. It requires usually not less than a couple of weeks to get a rejected shipment replaced, and this, in addition to the extra work thrown upon all the offices by returning materials, has produced a natural disposition not to return rejected shipments. Among the propositions made to obviate this difficulty was to announce to the manufacturers, that three shipments of rejected material would debar them from all orders for a year, thus making the continuance of their business depend on the quality of the material furnished. This method, it is believed, will be extremely difficult to enforce. Another method was to make it a part of the contract, when the order is placed, that if the material failed to fill specifications, and the Company decided to use it, owing to an emergency, they should be at liberty to do so at a deduction of one-third or one-half from the bill. Of these three methods—namely, return the material that does not fill specifications, decline to give orders if the material does not fill specifications, and use material at a diminution from the price, the latter seems possibly the most feasible and the fairest all around. The first is at present in force, the last is being discussed, with the idea of substituting it in part for the first—that is, materials which we decide to use due to an emergency will be paid for at a diminished rate. Nothing positive has yet been decided on this question, however.

It is, of course, fair that if the shipment of material is rejected, the manufacturer should question our analysis, and it is also fair that he should have a part of the sample which we worked on to submit to other chemists, if he desires to do so. We have accordingly adopted a plan of retaining the samples from all rejected shipments for two weeks. A portion of this retained sample is at the disposal of any manufacturer who feels aggrieved at our decision. He can have a portion of this sample and send it to any chemist that he chooses. Of course if there is a difference between the other chemist and ourselves we try to get together, and by interview, or by working on similar samples, or by referring the matter to a third party straighten the matter out. In general we have been very fortunate in not being upset in our tests. We have had a number of severe contests, both with manufacturers and with their chemists, but it is very rare that our results have been set aside. It is simple wisdom on the part of any man rejecting material that he should have a good fighting margin before he recommends the return of the shipment. If no question is raised within two weeks we throw the sample away and regard the transaction as ended.

TRANSPORTATION BY WATER.

THE Census Bureau has recently issued Bulletin No. 179, giving the statistics of Transportation by Water in the United States. The figures collected by the Census cover the year 1889, and have been arranged and prepared by Mr. Thomas J. Vivian, under the general direction of Pro-

NUMBER, REGISTERED TONNAGE, AND ESTIMATED VALUE OF ALL VESSELS ENGAGED IN FREIGHT TRANSPORTATION, REGISTERED IN UNITED STATES PORTS.

Geographical Divisions.	Total.			Steam Vessels.			Sailing Vessels.			Unrigged.		
	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.	Number.	Long Tons.	Value.
Atlantic Coast	12,453	2,794,440	$123,874,177	2,713	793,571	$70,593,090	6,400	1,383,108	$45,545,357	3,350	617,761	$7,735,730
Gulf of Mexico	1,008	77 562	3,851,270	220	45,591	2,961,450	613	17,249	788,110	175	14,722	101,710
Pacific Coast	1,842	441,939	23,067,370	531	170,503	15,526,455	822	208,080	6,715,570	489	63,356	825,345
Great Lakes	2,784	926,355	48,941,474	1,489	599,949	41,193,324	987	187,006	4,275,650	308	139,400	3,472,500
Mississippi Valley	7,453	3,393,380	15,335,005	1,114	210,772	10,539,251	....	....	....	6,339	3,182,608	4,795,754
Total	25,540	7,633,676	$215,069,296	6,067	1,820,386	$140,813,570	8,912	1,795,443	$57,324,687	10,561	4,017,847	$16,931,039

fessor Henry C. Adams. The Bulletin serves to show the great importance of water transportation to the country.

The total number, registered tonnage, and estimated value of all vessels engaged in the transportation of freight on December 31, 1889, are shown in the accompanying table.

The total tonnage carried during the year 1889 by these vessels is given as follows :

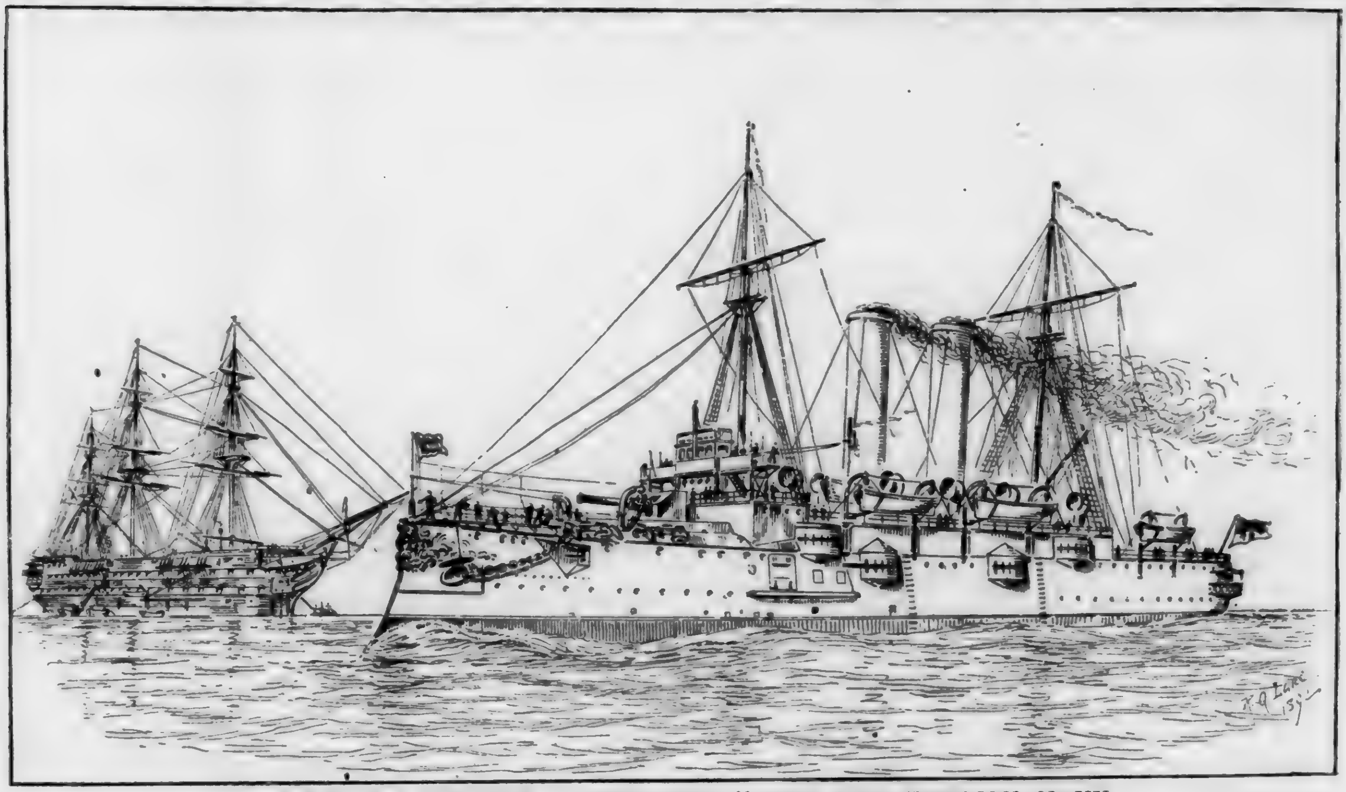
[Geographical Divisions.	Total all Craft.	By Steamers.	By Sailing Vessels.	On Unrigged Craft
Atlantic Coast..........	77,597,626	28,778,341	38,283.401	10,535,884
Gulf of Mexico..........	2,864,956	1,455.450	1,359,526	49,980
Pacific Coast............	8,818,363	5,741,940	2,761,826	314,597
Great Lakes..............	53,424,452	20,181,483	19,302,949	13,940,000
Mississippi Valley.......	29,405,046	10,345,504	....	19.059,542
Total.	172,110,423	66,502,718	61,707,702	43,900,003

From this table it will be seen that steamers carried 38.6 per cent. of the total tonnage ; sailing vessels, 35.9, and unrigged craft, 25.5 per cent. Arranging the freight tonnage by geographical divisions, we find 45 per cent. of the total credited to the Atlantic Coast, 2 to the Gulf of Mexico, 5 to the Pacific Coast, 31 to the Great Lakes, and 17 per cent. to the Mississippi Valley.

The Bulletin reports that in 1889 there were 106,436 persons employed on these craft, and that the wages paid them amounted to $36,867,305, being an average of $347 each. By far the largest number was on the Atlantic Coast, where 54,859 persons were reported—an average of 4.41 to each vessel. On the Gulf of Mexico there were 3,891, or 3.76 per vessel ; on the Pacific Coast, 15,809, or 8.58 per vessel ; on the Great Lakes, 15,881, or 5.60 per vessel ; and in the Mississippi Valley, 15,996, or 2.15 per vessel. Some of these averages seem unwarrantably low.

These statements do not include fishing vessels—a fleet of nearly 7,000 craft. These were not regarded as properly engaged in transportation, and will be the subject of a separate report.

With regard to the unrigged craft the Bulletin says : "Since 1881 the registration of barges and such other craft as have no motive power of their own has not been insisted on except in the infrequent case of those occupied in the carriage of bonded goods. The registration of barges, etc., having therefore largely become a matter of convenience and option, the records of the custom house contain but a very small proportion of the unrigged craft belonging to American owners, and the records of the census have been entirely made up from lists compiled from its own inquiries. An idea of the difference between the account of registered and unregistered barges may be gained from the statement that according to the statistics of the Commissioner of Navigation there were 1,185 registered barges to be found in all the customs districts of the United States, while, as the census table in question shows, there were 10,561 of such barges in operation in 1889, and even the excess of 9,376 by no means covers the existing number of craft of this description. The tonnage of these 10,561 barges was the exceedingly large one of 4,017,847, while the importance of this contingent to the American mercantile fleet is shown by its value, which has been estimated at no less than $16,931,039. The record of the freight carried by the unrigged craft was not an easy matter to secure, and it was found a particularly difficult task to separate the accounts of freight actually carried on unrigged craft from the comprehensive reports of the steamers furnishing the motive power by which transportation was effected. The figures in this third table therefore cannot be accepted as absolutely full, but at the same time the 43,900,003 tons given as the amount of freight moved on these unrigged craft must not be considered as an estimate, but as an actual account for so far as the investigation has gone."



FIRST-CLASS CRUISER "GIBRALTAR," FOR THE ENGLISH NAVY.

The tables show that there is still a large number of sailing vessels employed in the coasting traffic and on the lakes. In the Mississippi Valley the number of barges and other craft having no motive power and depending on towing is very large.

It may be added that, taking the totals, the average registered tonnage per steamer was 300 tons ; per sailing vessel, 202 tons ; and for each of the unrigged craft, 380 tons. The highest average tonnage per vessel, including all classes, was in the Mississippi Valley, where it was 455 tons ; the craft on the Great Lakes come second, with an average of 333 tons ; those of Pacific Coast third, with 240 tons ; the Atlantic Coast fourth, with 224 tons ; the Gulf of Mexico last, with only 77 tons. This is a somewhat unexpected result, but is probably accounted for by the number of small schooners and similar craft employed on the Atlantic in the coasting trade.

A NEW FIRST-CLASS CRUISER.

(From the London *Engineer*.)

THE accompanying sketch shows the first-class cruiser *Gibraltar*, which has just been launched from the Napier yard at Govan, Scotland. She is shown in Belfast Harbor, because a previous *Gibraltar*, one of the old line-of-battle ships, lies there, and has been introduced into the picture for the sake of contrast.

The new *Gibraltar* is a steel twin-screw cruiser of 7,700 tons displacement, having triple-expansion engines of 12,000 H.P. constructed by the Napiers, the builders of the hull. She is 360 ft. long and 60 ft. beam, and will draw a little over 24 ft. of water.

There are six double ended boilers, with 48 furnaces. The engines have cylinders 45 in., 59 in. and 88 in. in diameter and 51-in. stroke. With 5,500 H.P. it is expected that she will have a speed of 16 knots; with 10,000 H.P., 18¾ knots, and at 12,000 H.P., with forced draft, 19½ knots. The coal capacity is 850 tons and the cruising radius at slow speed is 10,000 knots.

The armament of the *Gibraltar* will consist of one 9.2-in. 22-ton gun; ten 6-in. 5½-ton rapid-fire guns, five in each broadside, six being on the upper deck and four in sponsons on the main deck. The secondary battery will include twelve 6-pdr. and three 3-pdr. rapid-fire guns, eight machine guns and two boat guns. There will be also four 14-in. torpedo-tubes.

The protective deck is of steel, with a maximum thickness of 5 in. and a minimum of 2 in. Above and below its slopes are coal bunkers. As the engines rise somewhat above this deck, the upper parts are protected by 5-in. inclined plates backed with teak. The conning-tower is of 12-in. plates; the larger guns are protected by steel shields. In addition to numerous water-tight compartments, the ship has a double bottom amidships.

The total estimated cost of the ship is $1,657,500, of which $916,500 will be for hull, masts and rigging, $487,500 for machinery, and the balance for armament, etc. She has two light masts.

The present *Gibraltar* is the eighth of the name in the Navy; the seventh—shown in the engraving—is now known as the *Grampian*. She is a wooden screw ship, built at Devonport in 1860, and is used as a training ship for boys at Belfast. She was finished just about the time when wooden walls began to give place to ironclads. She was twice in commission, but only for short periods, and has been a training ship for a long time.

THE LATEST DISCOVERY IN ELECTRICITY.

(W. E. C. Gordon in the *Nineteenth Century*.)

ON Wednesday, February 3, the Royal Institution in London was crowded with one of the most critical scientific audiences in the world, who were held spellbound for more than two hours while Mr. Tesla gave an account of his discoveries. Mr. Tesla is a young electrician born at Rieka, on the border of Montenegro, and now domiciled in America. The interest of the lecture lay not in the beautiful experiments with which it was illustrated, nor in the actual facts put forward, but in the hope which it held out that we may now draw back a little farther the veil which hides one of the most fascinating mysteries of nature—namely, the relations between light and electricity, and between matter and motion.

The tendency of modern science is to remove day by day the barriers between its branches. Our views of the phenomena of light and heat, of electricity and magnetism and even of matter and motion, are rapidly merging into one general theory of molecular physics, which is perhaps best expressed by the vortex theory of Sir William Thomson.

According to this theory, the whole of every part of space is filled with a fluid called ether, almost infinitely elastic. The historic experiments of Faraday, interpreted by the mathematical researches of Clerk Maxwell, have demonstrated almost beyond doubt that the same ether whose waves carry light and heat from the sun and stars to the earth also carries the waves of electric and magnetic induction which, as the daily experiments at Kew Observatory show, follow each outburst of solar activity.

Sir William Thomson holds that all that which we know as matter consists of vortices or whirlpools of this ether, which, from their rapid rotating motion, resist displacement, and therefore show the common properties of hardness and strength in the same way as a spinning top or gyroscope tends to keep its axis in a fixed direction. But whether the molecules or particles of what we know as matter are independent matter, or whether they are ether whirlpools, we know that they keep up an incessant hammering one on another and thus on everything in space.

Professor Crookes has shown that the forces contained in this bombardment are immensely greater than any forces we have yet handled, many millions of horse-power being contained in an ordinary room. Owing, however, to the forces being in every possible direction they neutralize each other, and no result of them is perceivable to our senses; but if ever we discover how to so direct their courses as to send the majority of them in the same direction, we shall have at our disposal forces as much exceeding any we are now acquainted with as the blow struck by a bullet exceeds the force required to pull the trigger of a gun. In fact, as Mr. Tesla put it in his lecture, "We shall then hook our machinery on to the machinery of nature." It is because they hold out to us a hope, however distant, of some day so guiding the ether storm, that the experiments of Nikola Tesla are of such transcendent interest and importance.

Professor Crookes, in his experiments on "radiant matter," has given us the first hint of a method of directing what, for want of more exact knowledge, we will call the molecules of matter. With the appliances at his command, however, he was unable to impart any great change of direction, but he succeeded in making that change manifest by reducing the disturbing forces acting against his directing force. In other words, he pumped out from glass bulbs and tubes nearly all the air or other gas that they contained, and the comparatively few particles left were then free to travel in any course imparted to them without much change caused by collision with others. This special direction was imparted by means of electricity, and gave us the beautiful phenomena of phosphorescence and radiant matter, which are now so well known in these experiments.

By means of suitably shaped terminals a stream of molecules is focussed on a given point. If a piece of carbon or platinum is placed at that point, it becomes white hot under the bombardment from identically the same cause which causes a sheet of flame to appear when a cannon shot strikes an iron target. If a ruby or other phosphorescent material is placed there, it glows with its characteristic color, and if a little delicately balanced vane or windmill is placed on one side of its fans it rapidly revolves. The forces available in these experiments were, however, almost indefinitely small, being, as it were, merely flying spray from the great torrent into which we have not yet been able to penetrate.

We now come to the advances made by Mr. Tesla.

In all the above experiments the electricity by which the directing force was imparted to the molecules was electricity of a comparatively slow alternation period—namely, electric currents oscillating about 80 to 100 times per second. It was as if we had tried to ventilate a room by causing a man to walk slowly through it with an umbrella. He would undoubtedly move the air, but would move it so slowly that ordinary methods would be insufficient to enable us to perceive its motion. In order to cause a rush of air we must put a rapidly moving fan or other suitable machinery. Mr. Tesla seeing this, abandoned the ordinary dynamo, which, as we have already noted, gives about 80 alternations per second, and the ordinary induction coil, which gives about the same number, and boldly constructed a dynamo which gives 20,000 alternations per second, and by connecting this to suitable condensers he multiplied its alternations until they reached 1,000,000 or 1,500,000 per second.

Then at once an entire set of new phenomena appeared, and the experimenter entered a region of mystery and hope. One of the first things noticed was, that either because these vibrations are too rapid to excite corresponding vibrations in the nerves of the body or from some other cause, no shock is felt from the current; and that though an ordinary current at 2,000 volts will kill, yet this current at 50,000 volts cannot be felt at all.

It was also found that the vibrations keep time in some unknown way with the vibrations of solid matter. Vulcanite is one of the best insulators known, and will entirely stop any ordinary current or discharge; but the stream of sparks between two poles with this current pours through a thick sheet of vulcanite as easily or even with greater ease than through air. It does not perforate it in any way, but passes through it as light passes through glass.

All the "Crookes" phenomena of radiant matter are almost indefinitely increased; it is the blow of mitrailleuse bullets compared to the blow of an air-ball thrown against the wind. The forces can be directed for a considerable distance through space without the aid of wires. Electric lamps light easily when attached to one single wire, and require no return conductor; and, more wonderful still, if metal plates are fixed on the roof and walls of a room and connected to the terminals, the whole atmosphere of that room, whether it be ether or whether it be particles of common matter, is thrown into a state of storm and agitation which can be at once made perceptible by bringing into the space tubes or globes from which the air has been partially exhausted. Such tubes, though without any metallic connections, yet glow and throb as if powerful currents of electricity were being sent through them from an ordinary induction coil.

A Crookes radiometer placed near a metal conductor from which neither spark nor glow is perceptible, yet rotates as if it were placed near a lamp or heated body, but rotates in the wrong direction, and, last of all, a true flame burns in which nothing is consumed.

When the discharge issues from a suitable terminal it has the appearance and roaring sound of a gas flame burning under too high a pressure, and gives off a considerable heat; to use Mr. Tesla's words again: "This is not unexpected, as all the force and heat in the universe is due to the falling together of lifted weights, and the same result is produced whether these weights have been lifted apart by chemical energy, and rest in the form of oxygen and hydrogen ready to combine chemically, or in the form of mechanical energy of moving molecules directed by the electric current."

On the same table on which Mr. Tesla's experiments were shown a few days ago there swung in the year 1834 a delicately balanced galvanometer needle, under the influence of the first induction current, produced by the genius of Faraday. The force available to move it was very small, probably not greater than the forces lighting Mr. Tesla's tubes, yet that force has now developed one of the great industries of the world. It lights millions of lamps in London and elsewhere; in America it drives cars on thousands of miles of railroad, and will soon distribute the power of Niagara Falls to the inhabitants of the neighboring States. May we not hope for such development of the new discovery, and that we shall some day harness to our machinery the natural forces, which from the beginning of time have literally been slipping through our fingers?

Should the application of Mr. Tesla's results ever fulfil the bold dreams of scientific imagination, we shall see a social and political change at least as important as that caused by the railway system or the electric telegraph.

Most manual labor will become unnecessary, as unlimited power will be available at every man's hand. Engineering works can be carried out on a far greater scale than has yet been contemplated, and doubtless a corresponding era of material prosperity will set in; but whether these dreams are ever fulfilled or not, few who attended Mr. Tesla's lecture will forget the possibilities which seemed to open to their minds when they saw a living man standing in the midst of the electric storm, receiving unharmed in his hands flashes of veritable lightning, and waving above his head a tube, through which the very life-blood of creation pulsed, in waves of purple fire.

A SPANISH RAILROAD BRIDGE.

SOME SPANISH RAILROAD NOTES.

FROM AN OCCASIONAL CORRESPONDENT.

GREAT progress has been made all over Spain in recent years in bridge building. The question often occurs to the traveler, What is the need for such long and handsome bridges? Where is the water? The truth is, that for nine or ten months of the year, in most cases, there is no water, and the river-bed is used for cart traffic, forming generally a better road than the ill-kept highways. Suddenly, during the wet season, along come the rain and melted snow from the mountains, filling the dry bed and often overflowing; sometimes in such volume as to sweep away heavy abutments and piers of masonry.

The first illustration given—taken in the dry season—shows a bridge over the Vilamajor River, on the railroad from Llinás to San Celoni. The river-bed is shown entirely dry and used as a road. This bridge is a riveted arch truss of 29 meters (95 ft.) span, on masonry abutments; it was built by the Sociedad Material para Ferrocarriles y Construcciones, of Barcelona.

The second illustration is of historic interest; it shows a very ancient masonry bridge near the town of Martorelli in the province of Barcelona, crossing the Noya River. This bridge is known as "El Puente del Diabolo"—the Devil's Bridge—the tradition being that his Satanic Maj-

esty was concerned in its building, and still occasionally shows himself under the archway at the center. This archway—a shelter and toll-house combined—is peculiar, and no similar construction is known to exist elsewhere in Spain. It is remarkable, by the way, how much the Devil has been, according to old-world tradition, mixed up in the bridge-building business; there is hardly a country in Europe that has not its "Devil's Bridge." In the more civilized New World, of course, our bridge-builders are as far removed as possible from any connection with Satanic or underground influences.

In this illustration, it may be noted that the bridge seen in the distance, through the arches of the old bridge, is the longest railroad bridge in Spain.

SPANISH CAR BUILDING.

There are at present three shops for the construction of railroad cars in Spain, and these are apparently enough for the demand. Two of them are in or near Barcelona, the commercial capital. The most important is that of the Maquinistá Terrestre y Maritimá, where locomotives also are built; the shops of that company are at Barceloneta. The second in rank, which your correspondent visited, is that of the Sociedad Material para Ferrocarriles y Construcciones, which has its offices in Barcelona and its works at the little town of Pueblo-Nuevo, near by.

It may be noted here that it is no easy matter to get information in Spain, as all the companies, both railroad and industrial, seem to fear comment and criticism. In all cases special permission must be obtained to visit or inspect shops, and this is not always readily granted.

The Sociedad above named has at its head a rich and aged proprietor, Sr. Manuel Girona. It employs about 500 men, and 150 of these are in the car shops. The passenger car shop—*fabrica des coches*—is a large and well-built shop; it is lighted by arc lights, as are all the buildings; the dynamos are made by the Sociedad Anglo-Española de Electricidad.

Of the 150 men in the shop over 50 are carpenters, and they have their benches in a long row, numbered in regular order. They work from 6 A.M. to 6 P.M., with an hour and a half off for meals; wages vary from 3 to 5¾ pesetas (58 cents to $1.10) per day. Saturday is pay-day, and the Spanish workman is not at his best on Monday, although the difference is not nearly so marked as in England, for instance.

Quick work is not usual. The time required for building a passenger coach is usually from 3 to 3½ months. Two months is the best time recorded; but in Spain nobody is in a hurry. The wheels, of wrought iron as elsewhere in Europe, are imported from France, Belgium, Germany or England; the rest of the work is of native manufacture, including upholstery and all the smaller fittings. Oil lamps are universally used; gas has never been introduced, and electricity is most likely to replace oil, should a change be made.

At the time the shops were visited there were 12 first, second and third-class coaches under way. One of these—for the Almansa-Valencia-Tarragona line—had a second story or "imperial," and was very similar to the double-storied cars in use on the Paris Suburban lines. How many of these double cars were in use could not be ascertained, but it was stated that they were very popular. They are well adapted to the climate, and it is a little surprising that they are not generally used.

In building freight cars—usually open trucks—a dozen will be laid down at a time, and the work on all carried on at once. They are usually built to carry 10,000 kilos., or about 22,000 lbs.

RAILROAD CONSOLIDATION.

The Almansa-Valencia-Tarragona line, referred to above—which is a line of considerable importance, built and owned by a company entirely Spanish—has just been consolidated with the Ferrocarril del Norte, also a Spanish company, with its headquarters in Madrid. With this incorporation the company becomes the leading Spanish railroad corporation, owning a little over 3,000 kilometers—1,865 miles—of road, chiefly single track. Its lines occupy the territory in the north and along the eastern or Mediterranean coast.

The company which now drops back to second place is the Caminos-de-Hierro del Mediodia, which owns the lines from Madrid to Zaragoza, Alicante, Ciudad-Real and Badajoz, covering western and a large part of southern Spain. This company has an ownership largely French, and is an exclusive and somewhat unpopular concern. Both the companies mentioned have been made up of a number of short lines.

As with manufacturing concerns, it is difficult to get information, and a copy of the annual report of one of the great companies is not to be had. Perhaps it is because the results to stockholders have not been altogether satisfactory, and the managers do not want to say too much until matters have improved. The railroad consolidations, it may be said, have much simplified and improved the management.

"EL PUENTE DEL DIABOLO," NEAR MARTORELLI, SPAIN.

THE LARGEST SAILING SHIP.

THE largest sailing ship in the world is the *Maria Rickmers*, which was launched on February 26 last from the yard of Russell & Company, at Port Glasgow, Scotland, and which has been built for the great shipping house of Rickmers, of Bremen.

This vessel is of steel, and is 375 ft. long over all, 48 ft. beam, and 28 ft. 5 in. deep. She will register 3,813 tons gross, and will have a carrying capacity of about 6,000 tons of freight. She has a double bottom and deep midship water tanks which will hold about 1,300 tons of water ballast. The equipment includes all the latest improvements in the way of hoisting gear, ventilators and other appliances.

The vessel has five masts and is bark rigged, carrying an enormous spread of canvas. In ordinary weather she

will be propelled by sails alone ; but she is also provided with machinery for use in case of need. This consists of a triple-expansion engine with cylinders 16 in., 26 in. and 42 in. in diameter and 27 in. stroke. The propeller is of gun-metal, and is of the Bevis feathering type, which is expected to do away with the usual objection to auxiliary screws, that they act as a drag when the ship is under sail. On the trial trip, in ballast, this engine developed 650 H.P. with 160 lbs. of steam, and gave the ship a speed of $7\frac{1}{2}$ knots.

Up to the completion of this ship, the largest sailing ship in the world was *La France*, a steel five-masted ship, built last year by Henderson & Son, at Glasgow, for a Bordeaux firm. *La France* is 361 ft. long, 48 ft. 8 in. beam, and registers 3,784 tons. The four-masted iron ship *Liverpool*, owned in Liverpool, is 333 ft. long, 47 ft. 9 in. beam, and 3,400 tons register. The largest wooden ship in existence is the *Shenandoah*, built and owned by Sewall & Company, of Bath, Me., which is 299 ft. 7 in. long, 49 ft. 1 in. beam, and 3,258 tons register ; she has carried over 5,000 tons, and some time ago took the largest wheat cargo on record—112,000 centals, or 5,600 net tons—out of the port of San Francisco.

The *Maria Rickmers* is nearly ready for her first voyage, which will be to the East Indies, it is said, after a cargo of rice.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(Continued from page 221.)

AEROPLANES.

Aeroplanes—*i.e.*, thin fixed surfaces, slightly inclined to the line of motion, and deriving their support from the upward reaction of the air pressure due to the speed, the latter being obtained by some separate propelling device, have been among the last aerial contrivances to be experimented upon in modern times.

The idea of obtaining sustaining power from the air with a fixed, instead of a vibrating or a rotating surface is not obvious, and it was not till 1842 that an aeroplane, as we now understand the term, consisting of planes to sustain the weight, and of a screw to propel, was first proposed and experimented with. All aviators must have occasionally seen and marveled at the performances of the soaring varieties of birds, sailing in every direction at will upon rigidly extended wings (a performance concerning which more will be said in the progress of this discussion), but the flapping birds are so much more numerous and easily observed, their action is so much easier of comprehension, that they have been the favorite model.

We shall see, however, in reviewing old traditions with perhaps a new understanding, that such faint approximations to success, as have hitherto been attained with artificial flying machines, were probably accomplished with fixed surfaces, either by gliding downward by the force of gravity, or in soaring upon the wind like a bird.

Although aeroplanes have been among the last devices to be experimented upon, they are now the favorite apparatus from which success is hoped for, and later designs have chiefly been in this direction. The very important labors of Professor Langley have shown that with the exertion of 1 horse power as many as 200 lbs. can be sustained in the air by an aeroplane, while Mr. *Maxim* states, as the result of his many experiments, that at least 133 lbs. can be sustained per horse power. If we compare this with the results of vibrating wings, which may be assumed as supporting 77 lbs. per horse power,* or with screws, which have been shown as affording generally 33 to 40 lbs. per horse power—chiefly, as the writer believes, because of the greater angle of incidence or of pitch which is required with alternating or rotating surfaces—we see that fixed surfaces possess a marked advantage over movable surfaces. The latter, it is true, can probably be made somewhat smaller and hence lighter, but this advantage is likely to be more than counterbalanced by the greater power required to work them.

Still the fact remains that almost all experiments with aeroplanes have hitherto been flat failures. This is believed by the writer to result from the difficulty of maintaining the equilibrium of that form of apparatus, both sideways and fore and aft. There seems to be no very great difficulty in obtaining proper balance and equilibrium with flapping wings or with screw apparatus, the motion of the parts apparently compensating to some extent for the tendency to tilt over, but fixed aeroplanes seem much more unstable—a single flat plane, for instance, of uniform weight throughout, possessing no sort of stability whatever when in forward rectilinear motion.

Perhaps the reader will best understand this, and at the same time obtain a glimpse of some of the laws of aerial equilibrium under forward motion, by experimenting with an aeroplane of his own.

Let him cut out a strip or parallelogram of stiff wrapping paper—say 15 in. long and 3 in. wide. Its sides should be straight and parallel, and the surface a true flat plane, free from folds or wrinkles. In this condition it may fall flatways a short distance with tolerable steadiness ; but if allowed to fall edgeways, or projected forward without whirling, it will at once rotate upon its long axis, tumble over and over, and be seen to have very unstable equilibrium. This can be remedied with very slight changes ; for next paste upon one of the long edges of the plane a strip of pasteboard $\frac{1}{2}$ of an inch wide and the same length as the paper plane. Part of an ordinary pasteboard box will do very well ; but the important point to be observed is that the apparatus shall balance on its middle line, and at a point 28 to 30 per cent. back from its front edge, or say, $\frac{7}{8}$ of an inch. When the paste is dry, make a very slight fold in the paper strip near the edge opposite to the pasteboard strip and parallel to it. Let this fold or crease be about $\frac{5}{8}$ of an inch from the rear edge, and form an angle of about 10° with the plane of the paper. Next bend the aeroplane parallel with the short sides and exactly in the center of the long sides, so that the two halves shall also stand at a diedral angle of about 10° with each other, like a very obtuse letter V, care being taken that middle fold and the back fold shall be on the same side of the plane. It will then be noticed that the attitude of the apparatus somewhat resembles that of a soaring buzzard in the air minus its tail.

If, now, this aeroplane be allowed to drop edgeways, with the weighted side downward, from a height of 7 ft. or more, its behavior will be entirely different from that in its former condition. Instead of tumbling over and over, it will sail downward and forward upon a curve until the increasing pressure balances the weight, and then glide on a straight path to the floor, some 15 or 20 ft. from the operator. It may not glide on a straight line upon the first trial, but in that event very slight changes in the angles of the back crease and of the middle fold, and a smoothing out of the plane will be sure to produce the desired forward flight and steady glide.

Still better results can be obtained by pasting a strip of tin $\frac{1}{4}$ in. wide in a fold in the forward edge of a plane 4 in. wide. For this purpose it will be well to have the strip of tin 15 in. long, and to cut the paper plane 20 in. long by 5 in. wide, so that 1 in. of the latter can be folded quite over and pasted down over the tin. The latter should be accurately spaced $2\frac{1}{2}$ in. from each end, so that the apparatus shall balance exactly on the middle line lengthways, and 1.2 in. from the weighted edge, crossways. The corners beyond the tin may be rounded off if desired, provided care be taken not to disturb the balance. Then by bending the apparatus very slightly in the center of its length, and turning up the rear edge about 10° in the same direction, an aeroplane will be produced which will sail steadily forward in still air, sweep to the right, if the right-hand back corner be slightly curved up, or go to the left when the left-hand corner is similarly treated.

The principle on which this aeroplane sails is the same as that upon which the bird glides downward on outstretched wings. The preponderance of the weight in

* Assuming a bird in horizontal flight to develop 425 ft. lbs. per minute for each pound of his weight, the sustaining reaction will be $\frac{33.000}{425} = 77$ lbs. per horse power.

front determines the angle of incidence, and brings the center of gravity to coincide with the center of pressure, the latter varying approximately as per Joëssel law, already given, which, however, it must be remembered, probably only applies to square planes; the horizontal component of the pressure (inasmuch as the plane is inclined forward) acts in the direction of the flight, and furnishes the motive power while the back fold supplies automatically the longitudinal stability by counteracting such tendency as the aeroplane may have to tilt fore and aft; and the diedral angle in the middle gives lateral stability, by reacting against the air on that side toward which the apparatus may begin to tip.

These compensations are effective in still air, but it may be doubted whether they are sufficient in the open air. When a bird soars in a gusty wind (and almost all winds are gusty and irregular in velocity near the surface of the ground), the automatic effects obtained by the diedral angle of the wings and the upward angle of the tail do not seem to act quickly enough. The bird will be seen, by observation at close range, to be almost constantly balancing himself by slight, almost unconscious movements. He advances the tips of his wings or thrusts them back; he flexes one or the other, and quite often he advances or draws back his head, or uses his legs as a pendule from the knee joint, in order to maintain his equilibrium. All birds are acrobats, but the soaring kind, if closely observed in a gusty wind, will be seen to perform feats of balancing more delicate and wonderful than those of any human equilibrist.

We shall hereafter see that even if the aeroplanes experimented with had been provided with adequate motors, as they were not, this difficulty in maintaining a proper equilibrium with fixed surfaces is probably sufficient to account for most of the failures of experiments upon a practical scale with that form of apparatus, and for their abandonment by their designers, a brief trial having probably satisfied them that aside from the question of a motive power, which they were confessedly unable to solve, they were not yet masters of such reasonable stability and command over their apparatus, as to warrant them in proceeding further. Now that the all-important question of a light motor seems to be in a fair way of being solved through the achievements of Mr. *Maxim*, M. *Trouvé*, and others who are known to be laboring in the same direction, the question of the equilibrium of aeroplanes increases in relative importance, and warrants making this somewhat prominent in criticising past experiments and proposals. For this and other reasons, we shall pass in review a number of mere designs as well as forms of apparatus which was actually subjected to the test of experiment, and endeavor to inquire into the causes of failure.

Failures, it has been said, are almost as instructive as successes, as intending to remove, if we can understand the cause, at least one of the difficulties in the way, and the reader will probably agree that there has been hitherto no lack of failures in aerial experiments.

There probably have been in all ages of the world men, whose imaginations were fired by the sight of the soaring birds, and some who tried to imitate them. In early times mechanical and mathematical knowledge was too crude to render such experiments numerous, and before the invention and diffusion of printing, even the records of such failures would generally perish; but a few legends have come down to us in abbreviated shape, which indicate that some then celebrated attempts and failures had taken place. No great faith can be attached to these legends, yet some of them are curious, if considered as the relation of attempts to sail upon the wind like soaring birds with rigid fixed surfaces.

Passing over as too scanty of record the myths of antiquity, perhaps the earliest legend of an experiment which we may fairly suppose to have been tried with an aeroplane is stated to be found in the somewhat fabulous chronicles of Britain,* wherein it is related that King *Bladud*, the father of King *Lear*, who is supposed to have reigned in Britain about the time of the founding of Rome, caused to be built an apparatus with which he sailed in the air above his chief city of Trinovante, but that, losing his balance, he fell upon a temple and was killed. This is about all there is of the legend, and as even that concerning King *Lear*, which Shakespeare worked up into his tragedy, has been suspected of being a myth, it is difficult to comment intelligently upon such a tradition; yet it is not impossible that King *Bladud* (who was reputed to be a wizard, as were all investigators in ancient times), should have attempted to imitate the ways of the eagle in the air, and should have succeeded in being raised by the wind, when, for lack of the balancing science of the bird, he should have lost his equilibrium, and with a shear, a plunge, or a whirl have come in disaster to the ground.

* Bescherelle, Histoire des Ballons, 1852.

A better authenticated legend seems to be that of *Simon the Magician*, who, in the thirteenth year of the reign of the Emperor *Nero* (about 67 A.D.), undertook to rise toward heaven like a bird in the presence of everybody.* The legend relates that "the people assembled to view so extraordinary a phenomenon and *Simon* rose into the air *through the assistance of the demons* in the presence of an enormous crowd. But that St. Peter, having offered up a prayer, the action of the demons ceased, and the magician was crushed in the fall and perished instantly."

"It seems, therefore, certain" (adds M. *de Graffigny*) "from this tale, which has come down to us without any material alteration, that even in that barbarous age a man succeeded in rising into the air from the earth by some means which have unfortunately remained unknown."

The writer has seen the feat performed by soaring birds many times. He has seen a gull, standing upon a pile-head within 20 ft. of him, float up into the air without flapping, by simply facing the wind, opening his wings to their full extent, and keeping them rigidly extended to a sea breeze blowing at the rate of 14.40 measured miles per hour. The gull rose vertically about 2½ ft. above the pile-head, then drifted back about 5 ft., still rising slightly, when he altered by a trifle his angle of incidence, advanced against the wind, losing a little height, and was thenceforth in full soaring activity. Many other writers have seen the same kind of performance, including the still more difficult feat seen by M. *Mouillard*,† who observed in Africa an eagle spring from the top of an ash-tree, and without a single flap first descend from 7 to 10 ft., going against the wind, and upon this freshening to a squall, rise directly and slowly some 300 ft. into the air, while *advancing against the wind* some 150 ft. at the same time.

The reader may be further interested by the account of a somewhat similar feat, published in *L'Aéronaute* of October, 1890, by Mr. *Charles Weyher*, and which he describes as follows:

"One day when I was close to the Aqueduct of *Buc*, and the wind was blowing strongly down the valley, and therefore at right angles to the aqueduct, I saw a sparrow hawk come out of a hole marked *A* (fig. 36) on the sketch,‡ near the top, and on the leeward side.

"The bird left his hole and dove downward, his wings scarcely opened, and thus reached like a dart a point about the center of the opening of one of the arches. At this moment, when at *B*, he stretched his wings wide open and began circling, continued his orbits, drifting with the wind, until he attained an elevation of 800 to 1,000 ft. At this elevation, or the point *C*, the sparrow hawk folded his wings almost completely and dove forward again upon a steep inclination, making use of the height gained to recover against the wind the distance which he had drifted, and to regain his hole, into which he entered gently, by simply opening his wings wide when within 7 to 10 ft. of the wall.

"It is well to observe that the bird in taking this journey, both going and coming back, expended no muscular work whatever, save the utterly inappreciable exertion of opening and folding up his wings twice."

The legend of *Simon the Magician*, which has led to the above digression, is clearly of Christian origin, as evidenced by the intervention of St. Peter, who is supposed to have been martyred in Rome about A D. 64. It is not known to be confirmed by any Roman record, such records having been largely destroyed during the dark ages; but

* Graffigny, La Navigation Aérienne, 1888.
† Mouillard, L'Empire de l'Air, 1881. Page 22.
‡ See following page for this sketch.

if the tradition be founded upon a fact, we may suppose *Simon*, after some preliminary trials, to have attempted to imitate, with a fixed aeroplane, in public some of the evolutions of a soaring bird, and being unable to perform skillfully the necessary manœuvres, to have lost his equilibrium and his life.

There is another monkish tradition of the eleventh century concerning *Oliver of Malmesbury*, who in some of the accounts is styled " Elmerus de Malemaria," and who was an English Benedictine monk, said to have been a deep student of mathematics and of astrology, thereby earning the reputation of a wizard. The legend relates * that

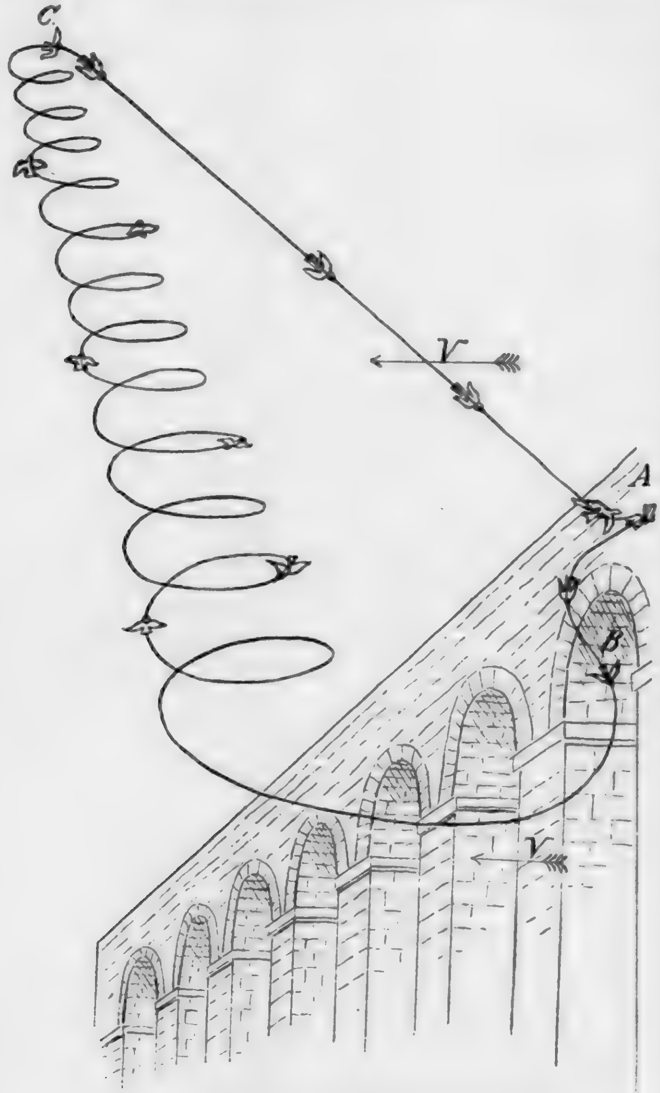


Fig. 36.—THE SPARROW-HAWK'S EXCURSION.

" having manufactured some wings, modeled after the description that *Ovid* has given of those of *Dedalus*, and having fastened them to his hands, he sprang from the top of a tower against the wind. He succeeded in sailing a distance of 125 paces ; but either through the impetuosity or whirling of the wind, or through nervousness resulting from his audacious enterprise, he fell to the earth and broke his legs. Henceforth he dragged a miserable, languishing existence (he died in 1060), attributing his misfortune to his having failed to attach a tail to his feet."

Commentators have generally made merry over this last remark, but in point of fact it was probably pretty near the truth. To perform the manœuvre described, of gliding downward against the breeze, utilizing both gravity and the wind, *Oliver of Malmesbury* must have employed an apparatus somewhat resembling the attitude of a gliding bird, but being unable to balance himself fore and aft, as does the bird by slight movements of his wings, head and legs, he would have needed even an ampler tail than the bird spreads on such occasions in order to maintain his equilibrium. He would have failed of true flight in any event, but he might have come down in safety.

A more explicit tradition of the same kind comes from Constantinople, where, under the reign of the Emperor *Manuel Comnenus*, probably about the year 1178, a *Saracen* (reputed to be a magician of course), whose name is not given, undertook to sail into the air from the top of the tower of the Hippodrome in the presence of the Emperor.

The quaint description of this attempt, as taken from the history of Constantinople by *Cousin*, and given both by *Graffigny* and by *Bescherelle*, so clearly describes an aeroplane as distinguished from movable wings, and so well indicates the difficulty of obtaining and maintaining a proper balance with such an apparatus, that it is worth quoting :

" He stood upright, clothed in a white robe, very long and very wide, whose folds, stiffened by willow wands, were to serve as sails to receive the wind. All the spectators kept their eyes intently fixed upon him, and many cried, ' Fly, fly, O Saracen ! do not keep us so long in suspense while thou art weighing the wind !'—*i.e.*, adjusting the angle of incidence and the equilibrium of the machine.

" The Emperor, who was present, then attempted to dissuade him from this vain and dangerous enterprise. The Sultan of Turkey in Asia, who was then on a visit to Constantinople, and who was also present at this experiment, halted between dread and hope, wishing on the one hand for the Saracen's success, and apprehending on the other that he should shamefully perish. *The Saracen kept extending his arms to catch the wind.* At last, when he deemed it favorable, *he rose into the air like a bird ;* but his flight was as unfortunate as that of *Icarus*, for the weight of his body having more power to draw him downward than his artificial wings had to sustain him, he fell and broke his bones, and such was his misfortune that instead of sympathy there was only merriment over his misadventure."

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Granting the tradition to be true, the apparatus used by *Dante* must have been more manageable than any of its predecessors, for the accident is said to have been due to a breakage instead of a loss of balance. The latter, however, must have been still deficient, or *Dante* would have renewed his experiments with a stronger forging. He may have reasoned, moreover, that as the wind does not blow with the requisite speed every day, and he knew of no sufficiently light motor to take its place, the use of a soaring machine would be very limited; but it is very unfortunate that we should have no description of the machine and its mode of operation.

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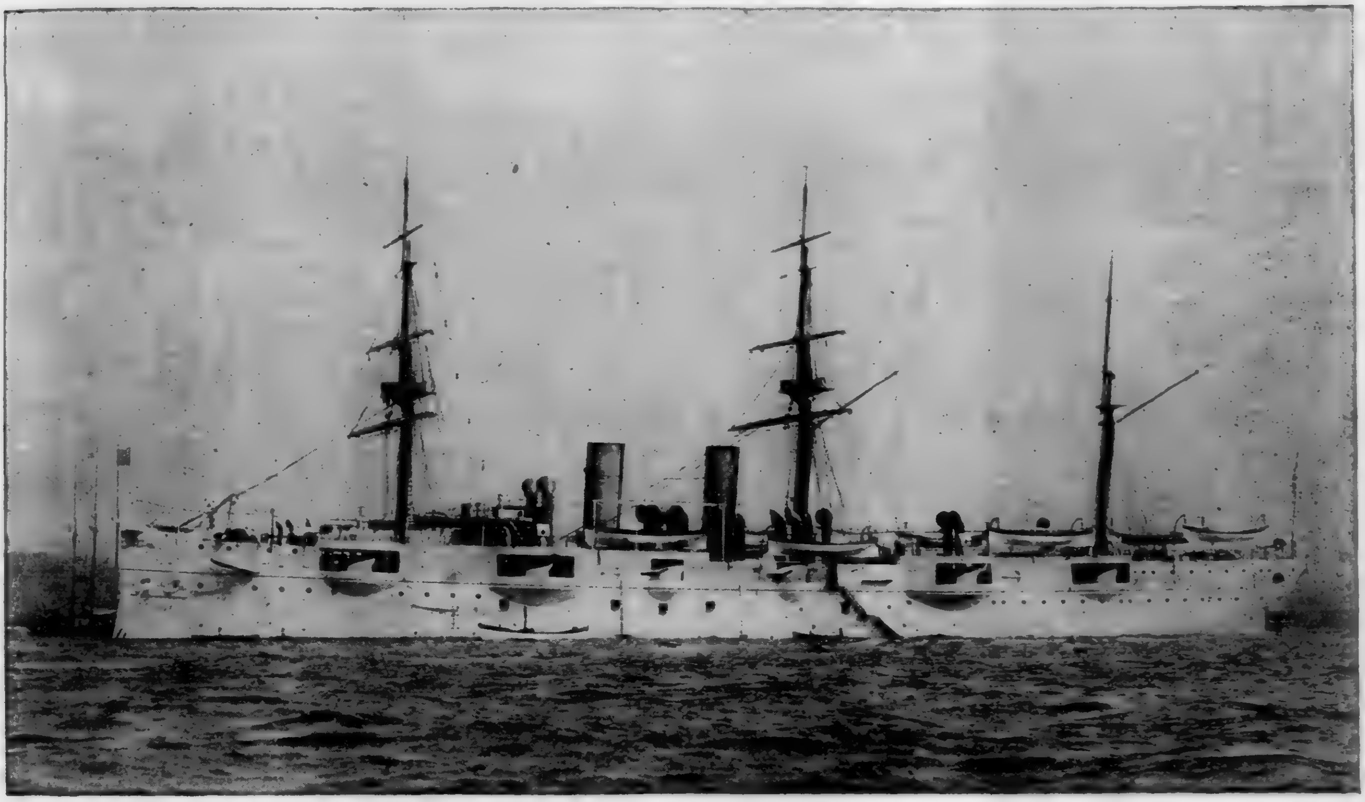
THE accompanying illustration is from a photograph of the *Newark*, one of the first of the large cruisers ordered for the Navy, and the first entirely designed by the Department. The general appearance of the ship, the number of masts, etc., are shown by the engraving.



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The *Newark* was built at the Cramp yards, in Philadelphia, and was launched in March, 1891. She is a steel cruiser with twin screws, and her principal dimensions are: Length over all, 329 ft.; length on load water-line, 310 ft.; molded breadth, 49 ft.; extreme breadth, 49.14 ft.; depth from flat keel plates to under side of spar-deck, 31.80 ft.; mean draft, 18 825 ft.; displacement to load water-line, 4,083 tons; tons per inch at load water-line, 24 96; area of load water-plane, 10,481 sq. ft.; area of immersed midship section, 807.23 sq. ft.

The battery consists of ten 6-in. rifled cannon mounted on central pivot carriages. None of these guns are mounted on the forecastle or poop-deck, but are carried underneath each of these decks. There is also a heavy secondary battery of rapid-fire and machine guns.

The motive power is furnished by two triple-expansion engines, one to each screw, having cylinders 34 in., 48 in. and 76 in. in diameter and 40 in. stroke. There are four boilers 13 ft. 6 in. in diameter and 19 ft. 6 in. long, intended to carry a working pressure of 160 lbs. The engines work up to about 6,000 H.P. with natural draft and 8,500 H.P. with forced draft. The ship has made over 19 knots an hour.

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if the tradition be founded upon a fact, we may suppose *Simon*, after some preliminary trials, to have attempted to imitate, with a fixed aeroplane, in public some of the evolutions of a soaring bird, and being unable to perform skillfully the necessary manœuvres, to have lost his equilibrium and his life.

There is another monkish tradition of the eleventh century concerning *Oliver of Malmesbury*, who in some of the accounts is styled "Elmerus de Malemaria," and who was an English Benedictine monk, said to have been a deep student of mathematics and of astrology, thereby earning the reputation of a wizard. The legend relates * that

FIG. 36. THE SPARROW HAWK'S EXCURSION

"having manufactured some wings, modeled after the description that *Ovid* has given of those of *Dedalus*, and having fastened them to his hands, he sprang from the top of a tower against the wind. He succeeded in sailing a distance of 125 paces; but either through the impetuosity or whirling of the wind, or through nervousness resulting from his audacious enterprise, he fell to the earth and broke his legs. Henceforth he dragged a miserable, languishing existence (he died in 1060), attributing his misfortune to his having failed to attach a tail to his feet."

Commentators have generally made merry over this last remark, but in point of fact it was probably pretty near the truth. To perform the manœuvre described, of gliding downward against the breeze, utilizing both gravity and the wind, *Oliver of Malmesbury* must have employed an apparatus somewhat resembling the attitude of a gliding bird, but being unable to balance himself fore and aft, as does the bird by slight movements of his wings, head and legs, he would have needed even an ampler tail than the bird spreads on such occasions in order to maintain his equilibrium. He would have failed of true flight in any event, but he might have come down in safety.

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THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

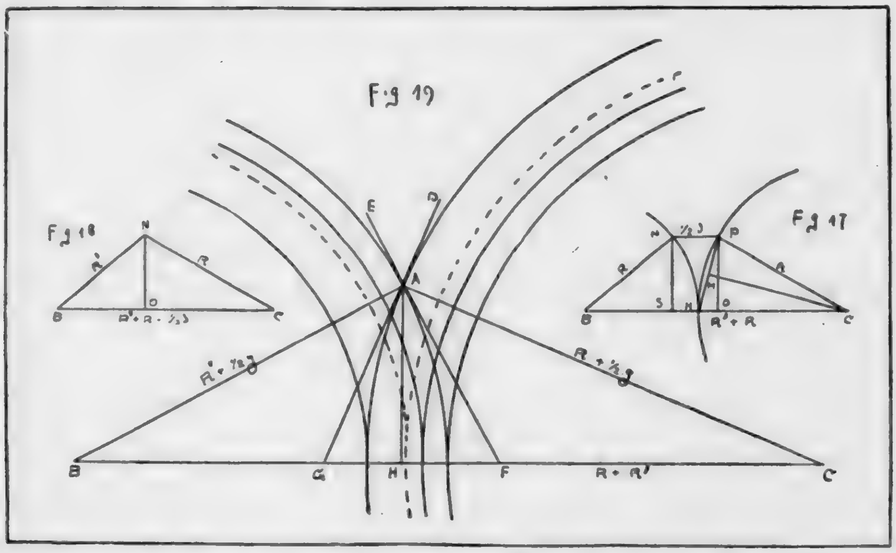
(*Continued from page 226.*)

TURNOUTS FROM THE OUTSIDE OF CURVES.

As with turnouts from the inside of curves, we will consider the subject as coming under two cases.

CASE I.

Under this head we will consider the case where the main track curve is to the right, with the turnout curve to the left, with the third rail on the right of the center, as shown in fig. 19.



LENGTH OF THROW-RAILS.

In fig. 17 let $H P$ represent the center line of main track and $H N$ the center line of turnout curve, R the radius of main track, R' the radius of the turnout curve, and assume $N P = \frac{1}{2} d$ as the throw. The trapezoid $B N P C$ is equivalent to the triangles $B N S$ and $P O C$ and the parallelogram $N P S O$. Subtracting the parallelogram $N P S O$, we have the oblique triangle $B N C$, fig. 18, where the side $B N = R'$, $N C = R$ and $B C = R + R' - \frac{1}{2} d$.

$$\text{Let } s = \frac{R' + (R + R' - \frac{1}{2} d) + R}{2},$$

Then from trigonometry,

$$Sin.\ \tfrac{1}{2} N C O = \sqrt{\frac{[s - (R + R' - \frac{1}{2} d)]\,[s - R]}{R \times (R + R' - \frac{1}{2} d)}}.$$

But the *sin.* $\frac{1}{2} N C O$ is equal to the *sin.* $P C M$ in the right-angled triangle $M C P$, where $P M$ is equal to the half chord of the throw-rail, and from trigonometry,

$$P M = R \times sin.\ P C M. \qquad (21)$$

Example: Given the radius of main track, $R = 955.37$, the radius of turnout track $R' = 716.78$, and the throw $\frac{1}{2} d = 5$ in. $= 0.417$ ft., to find the length of chord of throw-rail $P H$.

Here

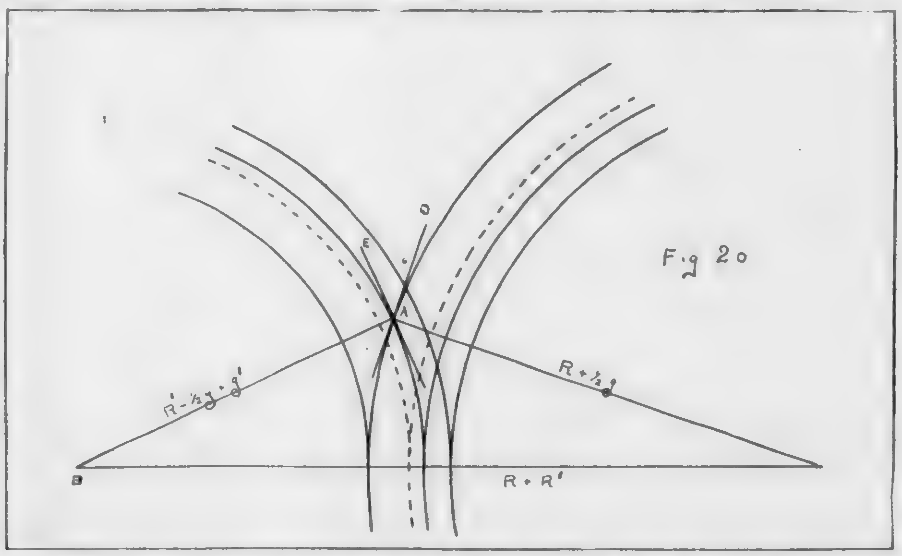
$$s = \frac{716.78 + (955.37 + 716.78 - 0.417) + 955.37}{2} = 1671.941$$

$s - (R + R' - \frac{1}{2} d) = 0.208$	$\bar{1}.3180633$
$s - R = 716.571$	2.8552592
$R = 955.370$ ar. comp.	7.0198284
$R + R' - \frac{1}{2} g = 1671.733$ ar. comp.	6.7768331
Extracting sq. root	$2)15.9699840$
$Sin.\ \frac{1}{2} N C O = 0°\ 33'\ 13''$	$\bar{7}.9849920$

Then in the right-angled triangle $M C P$,

$R = 955.37$	2.9801716
$P C M = 0°\ 33'\ 13''$ .... *sin.*	7.9849920
$P M = 9.229 = 9'\ 2\frac{3}{4}''$	0.9651636

whence $P H = 18'\ 5\frac{1}{2}''$.



The length of the arc $H P$ may be found in the manner described in Eq. 8.

To find the frog angles $D A E = G A F$, fig. 19, of the first frog, given the radius of main track $= R$, the radius of a turnout track $= R'$, the standard gauge $= g$ and the narrow gauge $= g'$.

In the case of a turnout from the outside of a curve in

different directions, the frog angle is equal to the sum of the two central angles.

Thus the angle $C A G = A H C$, also the angle $C A G = C A H + H A G$ and the angle $A H C = C A H + H C A$, from which the angle $H C A = H A G$.

Likewise the angle $B A F = B H A$, also the angle $B A F = B A H + H A F$ and the angle $B H A = B A H + H B A$, from which the angle $H B A = H A F$. The angles $H C A + H B A = H A G + H A F$ and the angles $H A G + H A F = G A F = D A E$.

For convenience of calculation, we may at once find the angle $B A C$ and subtracting which from 180°, we have the frog angle $D A E$.

In the triangle $B A C$ we have the side $B A = R' + \frac{1}{2} g$, $A C = R + \frac{1}{2} g$ and $B C = R + R'$ to find the angle $B A C$.

Let $s = \dfrac{(R + R') + (R + \frac{1}{2} g) + (R' + \frac{1}{2} g)}{2}$.

Then from trigonometry,

$$Sin. \tfrac{1}{2} B A C = \sqrt{\frac{[s - (R + \frac{1}{2} g)]\ [s - (R' + \frac{1}{2} g)]}{(R + \frac{1}{2} g)\ (R' + \frac{1}{2} g)}}. \quad (22)$$

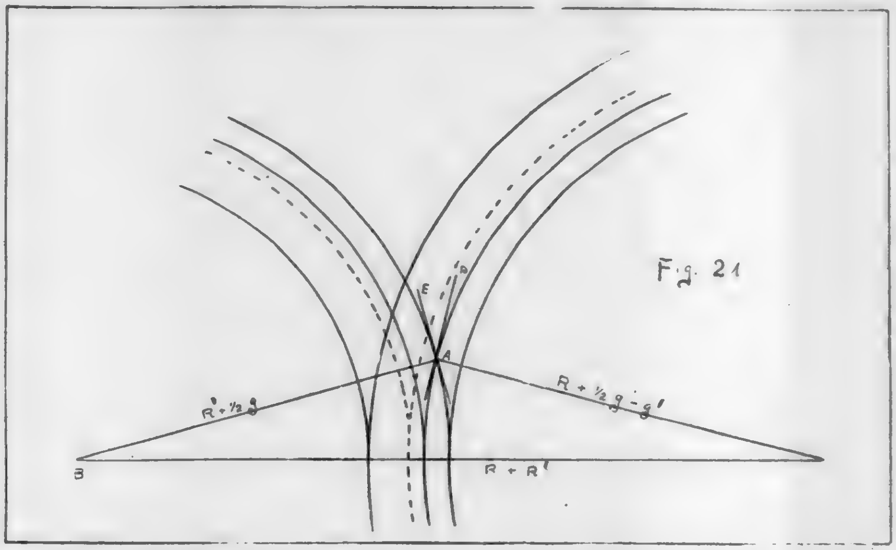


Fig. 21

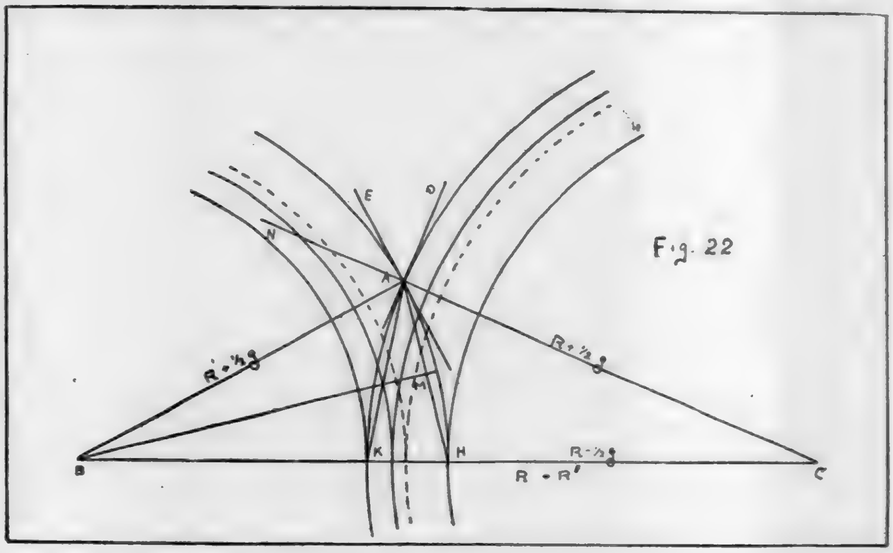


Fig. 22

Fig. 23

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, and the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\ A\ E$, fig. 19:

$$s = \frac{(2864.93+763.84)+(2864.93+2.354)+(763.84+2.354)}{2} = 3631.124$$

$s - (R + \frac{1}{2} g) = 763.840$	2.8830024
$s - (R' + \frac{1}{2} g) = 2864.930$	3.4571141
$R + \frac{1}{2} g = 2867.284$ ar. comp.	6.5425292
$R' + \frac{1}{2} g = 766.194$ ar. comp.	7.1156612
Extracting sq. root	2)19.9983069
$\frac{1}{2} B\ A\ C = 86°\ 25'\ 25''$ ....*sin.*	9.9991534

whence $B\ A\ C = 172°\ 50'\ 50''$ and $D\ A\ E = 180° - 172°\ 50'\ 50'' = 7°\ 09'\ 10''$, the angle required.

To find the frog angle $D\ A\ E$, fig. 20, of the second frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\ A\ C$ there are given the side $B\ A = R' - \frac{1}{2} g + g'$, $A\ C = R + \frac{1}{2} g$ and $B\ C = R + R'$.

Letting

$$s = \frac{(R + R') + (R + \frac{1}{2} g) + (R' - \frac{1}{2} g + g')}{2}$$

from trigonometry,

$$Sin. \tfrac{1}{2}\ B\ A\ C = \sqrt{\frac{[s - (R + \frac{1}{2} g)]\ [s - (R' - \frac{1}{2} g + g')]}{(R + \frac{1}{2} g)\ (R' - \frac{1}{2} g + g')}}. \quad (23)$$

Example: Given the radius of main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\ A\ E$, fig. 20:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354) + (763.84 - 2.354 + 3.00)}{2} = 3630.270$$

$s - (R + \frac{1}{2} g) = 762.986$	2.8825166
$s - (R' - \frac{1}{2} g + g') = 2865.784$...	3.4572434
$R + \frac{1}{2} g = 2867.284$ ar. comp.	6.5425292
$R' - \frac{1}{2} g + g' = 764.486$ ar. comp..	7.1166305
Extracting sq root.	2)19.9989197
$\frac{1}{2} B\ A\ C = 87°\ 08'\ 34''$ ....*sin.*	9.9994598

whence the angle $B\ A\ C = 174°\ 17'\ 08''$ and the angle $D\ A\ E = 180° - 174°\ 17'\ 08'' = 5°\ 42'\ 52''$, the required answer.

To find the frog angle $D\ A\ E$, fig. 21, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\ A\ C$ we have the side $B\ A = R' + \frac{1}{2} g$, $A\ C = R + \frac{1}{2} g - g'$, and $B\ C = R + R'$.

$$\text{Letting } s = \frac{(R + R') + (R + \frac{1}{2} g - g') + (R' + \frac{1}{2} g)}{2}$$

we have from trigonometry

$$Sin. \tfrac{1}{2} B\ A\ C = \sqrt{\frac{[s - (R + \frac{1}{2} g - g')]\ [s - (R' + \frac{1}{2} g)]}{(R + \frac{1}{2} g - g')\ (R' + \frac{1}{2} g)}}. \quad (24)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\ A\ E$, fig. 21:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354 - 3.00) + (763.84 + 2.354)}{2} = 3629.624$$

$s - (R + \frac{1}{2} g - g') = 765.340$...	2.8838544
$s - (R' + \frac{1}{2} g) = 2863.430$......	3.4568865
$R + \frac{1}{2} g - g' = 2864.284$ ar. comp.	6.5429840
$R' + \frac{1}{2} g = 766.194$ ar. comp.	7.1156612
Extracting sq. root...........	2)19.9993861
$\frac{1}{2} B\ A\ C = 87°\ 50'\ 45''$........*sin.*	9.9996930

whence the angle $B\ A\ C = 175°\ 41'\ 30''$ and the angle $D\ A\ E = 180° - 175°\ 41'\ 30'' = 4°\ 18'\ 30''$, the required answer.

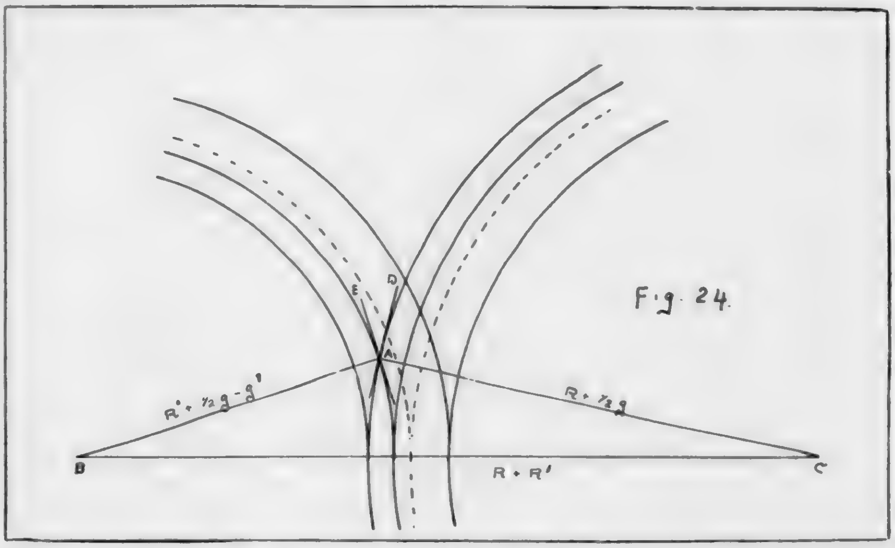
CASE II.

We will now consider the case where the main track curve is to the right, with the turnout curve to the left, with the third rail on the left of the center, as shown in fig. 22.

In a similar manner to that employed in Case I., it may be shown that the frog angle $D\ A\ E = A\ B\ C + A\ C\ B$, and also, as in this case, for convenience, we at once calculate the angle $B\ A\ C$ and find $D\ A\ E = 180° - B\ A\ C$.

To find the first frog angle $D\ A\ E$, fig. 22, given the radius of the main track $= R$, the radius of the turnout curve $= R'$, and the standard gauge $= g$.

In the triangle $B\ A\ C$ there are given $B\ A = R' + \frac{1}{2} g$, $A\ C = R + \frac{1}{2} g$ and $B\ C = R + R'$, to find the angle $B\ A\ C$.



Since these sides are the same as in Eq 22, the angles must also be equal, and therefore the angle $B\ A\ C$ may be found by the same equation—viz.:

$$Sin. \tfrac{1}{2}\ B\ A\ C = \sqrt{\frac{[s - (R + \frac{1}{2} g)]\ [s - (R' + \frac{1}{2} g)]}{(R + \frac{1}{2} g)\ (R' + \frac{1}{2} g)}}.$$

To find the second frog angle $D\ A\ E$, fig. 23, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\ A\ C$ there are given the side $B\ A = R' + \frac{1}{2} g$, $A\ C = R - \frac{1}{2} g + g'$, and $B\ C = R + R'$, to find the angle $B\ A\ C$.

$$\text{Letting } s = \frac{(R + R') + (R - \frac{1}{2} g + g') + (R' + \frac{1}{2} g)}{2}$$

we have from trigonometry,

$$Sin. \tfrac{1}{2} B\ A\ C = \sqrt{\frac{[s - (R - \frac{1}{2} g + g')]\ [s - (R' + \frac{1}{2} g)]}{(R - \frac{1}{2} g + g')\ (R' + \frac{1}{2} g)}}. \quad (25)$$

Example: Given the radius of the main track $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\ A\ E$, fig. 23:

$$s = \frac{(2864.93 + 763.84) + (2864.93 - 2.354 + 3.00) + (763.84 + 2.354)}{2} = 3630.270$$

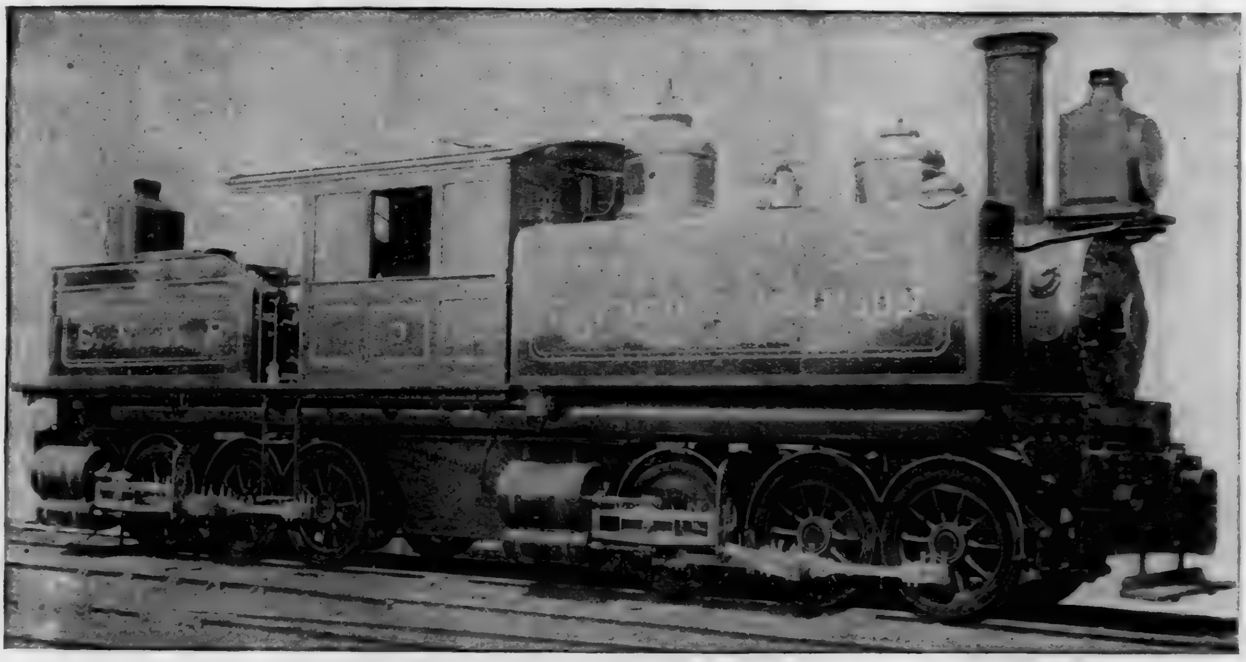
$s - (R - \frac{1}{2}g + g') = 764.694$...	2.8834877
$s - (R' + \frac{1}{2}g) = 2864.076$........	3.4569845
$R - \frac{1}{2}g + g' = 2865.576$ ar. comp.	6.5427881
$R' + \frac{1}{2}g = 766.194$ ar. comp......	7.1156612
Extracting sq. root...........	2)19.9989215
$\frac{1}{2} B A C = 87° 08' 43''$........*sin.*	9.9994607

whence the angle $B A C = 174° 17' 26''$ and the angle $D A E = 180° - 174° 17' 26'' = 5° 42' 34''$, the angle required.

To find the third or double-pointed frog angle $D A E$, fig. 24, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B A C$, we have given the side $B A = R' + \frac{1}{2}g - g'$, $A C = R + \frac{1}{2}g$, and $B C = R + R'$.

$$\text{Let } s = \frac{(R + R') + (R + \frac{1}{2}g) + (R' + \frac{1}{2}g - g')}{2}.$$



DOUBLE-TRUCK COMPOUND LOCOMOTIVE BY THE BALDWIN LOCOMOTIVE WORKS.

Then from trigonometry

$$Sin. \tfrac{1}{2} B A C = \sqrt{\frac{[s-(R+\frac{1}{2}g)]\,[s-R'+\frac{1}{2}g-g')]}{(R+\frac{1}{2}g)\,(R'+\frac{1}{2}g-g')}}. \quad (26)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D A E$, fig. 24:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354) + (763.84 + 2.354 - 3.00)}{2} = 3629.624$$

$s - (R + \frac{1}{2}g) = 762.340$	2.8821487
$s - (R' + \frac{1}{2}g - g') = 2866.430$..	3.4573414
$R + \frac{1}{2}g = 2867.284$ ar. comp.....	6.5425292
$R' + \frac{1}{2}g - g' = 763.194$ ar. comp.	7.1173650
Extracting sq. root...........	2)19.9993843
$\frac{1}{2} B A C = 87° 50' 34''$........*sin.*	9.9996921

whence the angle $B A C = 175° 41' 08''$ and the angle $D A E = 180° - 175° 51' 08'' = 4° 18' 52''$, the answer required.

(TO BE CONCLUDED.)

A DOUBLE-TRUCK COMPOUND LOCOMOTIVE.

THE accompanying illustration is from a photograph of a locomotive of exceptional type, recently built by the Baldwin Locomotive Works, in Philadelphia, for the Sinnemahoning Valley Railroad, a short line in Northwest Pennsylvania, having very heavy grades and sharp curves.

The entire weight of the engine is carried on 12 driving-wheels arranged in two groups of six, each group with its cylinders working in a separate frame and forming a truck or bogie. It differs from the Fairlie double-bogie engine in having a boiler of the ordinary form, and rather resembles the double-truck engines which were built by the late William Mason at Taunton several years ago.

Each truck has four cylinders, the engine being a compound of the Vauclain type. Steam is carried to the rear cylinders by a steam-pipe under the running-board. Water is carried in two side tanks and in a tank on the rear end of the frame. The engine is of the standard 4 ft. 8½ in. gauge.

The boiler is 50 in. diameter of barrel, and has 167 tubes 2 in. in diameter and 12 ft. long. The fire-box is 66 in. long and 47⅜ in. wide inside, the depth being 59½ in. at the front end and 40 in. at the back.

The high-pressure cylinders are 9½ in. and the low-pressure 16 in. in diameter, all being 18 in. stroke. The driving-wheels are 40 in. in diameter. The rigid wheel-base of each truck is 7 ft. 6 in.; the total wheel-base is 27 ft. 6 in.

The tanks will hold 2,500 galls. of water, 1,600 in the two side-tanks and 900 in the tank on the rear end. The engine is intended to run in either direction, and has a headlight on each end.

The total weight of this engine with tanks full and three gauges of water in the boiler, but without fire, is 150,400 lbs.; of this 72,100 lbs. are carried on the front section or truck, and 78,300 lbs. on the back section, the average weight per wheel being 6 tons on the front and 6½ tons on the back section.

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THE Youngstown Bridge Company, Youngstown, O., has taken a contract for an iron building 46 × 86 ft. in size, to be used as a boiler-house at the Exposition.

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Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, and the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\,A\,E$, fig. 19:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354) + (763.84 + 2.354)}{2} = 3631.124$$

$s - (R + \frac{1}{2}g) = 763.840$	2.8830024
$s - (R' + \frac{1}{2}g) = 2864.930$	3.4571141
$R + \frac{1}{2}g = 2867.284$ ar. comp.	6.5425292
$R' + \frac{1}{2}g = 766.194$ ar. comp.	7.1156612
Extracting sq. root	2)19.9983069
$\frac{1}{2}\,B\,A\,C = 86°\ 25'\ 25''$ ....*sin.*	9.9991534

whence $B\,A\,C = 172°\ 50'\ 50''$ and $D\,A\,E = 180° - 172°\ 50'\ 50'' = 7°\ 09'\ 10''$, the angle required.

To find the frog angle $D\,A\,E$, fig. 20, of the second frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ there are given the side $B\,A = R' - \frac{1}{2}g + g'$, $A\,C = R + \frac{1}{2}g$ and $B\,C = R + R'$.

Letting

$$s = \frac{(R + R') + (R + \frac{1}{2}g) + (R' - \frac{1}{2}g + g')}{2}$$

from trigonometry,

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R + \frac{1}{2}g)]\,[s - (R' - \frac{1}{2}g + g')]}{(R + \frac{1}{2}g)\,(R' - \frac{1}{2}g + g')}} \qquad (23)$$

Example: Given the radius of main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\,A\,E$, fig. 20:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354) + (763.84 - 2.354 + 3.00)}{2} = 3630.27$$

$s - (R + \frac{1}{2}g) = 762.986$	2.8825166
$s - (R' - \frac{1}{2}g + g') = 2865.784$...	3.4572434
$R + \frac{1}{2}g = 2867.284$ ar. comp.	6.5425292
$R' - \frac{1}{2}g + g' = 764.486$ ar. comp..	7.1166305
Extracting sq. root.	2)19.9989197
$\frac{1}{2}\,B\,A\,C = 87°\ 08'\ 34''$ ....*sin.*	9.9994598

whence the angle $B\,A\,C = 174°\ 17'\ 08''$ and the angle $D\,A\,E = 180° - 174°\ 17'\ 08'' = 5°\ 42'\ 52''$, the required answer.

To find the frog angle $D\,A\,E$, fig. 21, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ we have the side $B\,A = R' + \frac{1}{2}g$, $A\,C = R + \frac{1}{2}g - g'$, and $B\,C = R + R'$.

Letting $s = \dfrac{(R + R') + (R + \frac{1}{2}g - g') + (R' + \frac{1}{2}g)}{2}$

we have from trigonometry

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R + \frac{1}{2}g - g')]\,[s - (R' + \frac{1}{2}g)]}{(R + \frac{1}{2}g - g')\,(R' + \frac{1}{2}g)}} \qquad (24)$$

Example: Given the radius of the main track, $R = 2864.93$, the radius of the turnout $R' = 763.84$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft., to find the frog angle $D\,A\,E$, fig. 21:

$$s = \frac{(2864.93 + 763.84) + (2864.93 + 2.354 - 3.00) + (763.84 + 2.354)}{2} = 3629.621$$

$s - (R + \frac{1}{2}g - g') = 765.340$...	2.8838544
$s - (R' + \frac{1}{2}g) = 2863.430$.......	3.4568865
$R + \frac{1}{2}g - g' = 2864.284$ ar. comp.	6.5429840
$R' + \frac{1}{2}g = 766.194$ ar. comp.	7.1156612
Extracting sq. root	2)19.9993861
$\frac{1}{2}\,B\,A\,C = 87°\ 50'\ 45''$ ....*sin.*	9.9996930

whence the angle $B\,A\,C = 175°\ 41'\ 30''$ and the angle $D\,A\,E = 180° - 175°\ 41'\ 30'' = 4°\ 18'\ 30''$, the required answer.

CASE II.

We will now consider the case where the main track curve is to the right, with the turnout curve to the left, with the third rail on the left of the center, as shown in fig. 22.

In a similar manner to that employed in Case I., it may be shown that the frog angle $D\,A\,E = A\,B\,C + A\,C\,B$, and also, as in this case, for convenience, we at once calculate the angle $B\,A\,C$ and find $D\,A\,E = 180° - B\,A\,C$.

To find the first frog angle $D\,A\,E$, fig. 22, given the radius of the main track $= R$, the radius of the turnout curve $= R'$, and the standard gauge $= g$.

In the triangle $B\,A\,C$ there are given $B\,A = R' + \frac{1}{2}g$, $A\,C = R + \frac{1}{2}g$ and $B\,C = R + R'$, to find the angle $B\,A\,C$.

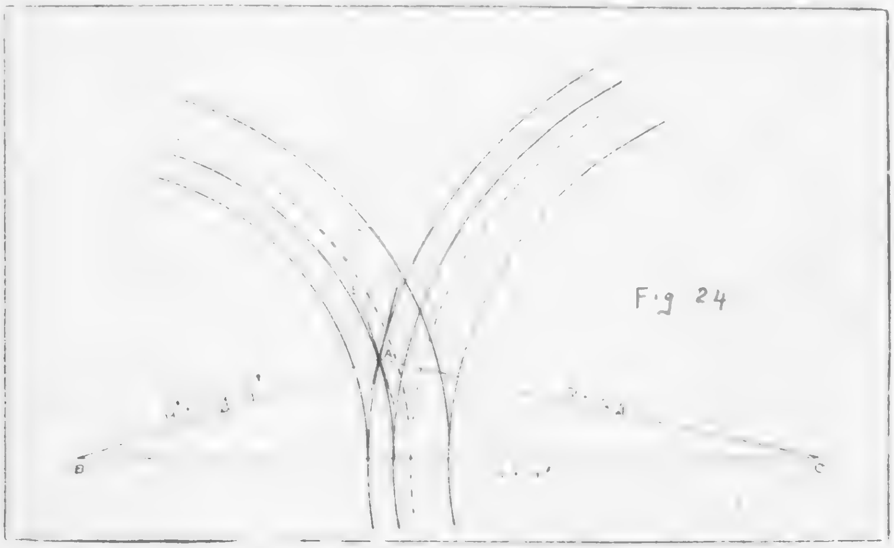

Fig 24

Since these sides are the same as in Eq. 22, the angles must also be equal, and therefore the angle $B\,A\,C$ may be found by the same equation—viz.:

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R + \frac{1}{2}g)]\,[s - (R' + \frac{1}{2}g)]}{(R + \frac{1}{2}g)\,(R' + \frac{1}{2}g)}}$$

To find the second frog angle $D\,A\,E$, fig. 23, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge g'.

In the triangle $B\,A\,C$ there are given the side $B\,A = R' + \frac{1}{2}g$, $A\,C = R - \frac{1}{2}g + g'$, and $B\,C = R + R'$, to find the angle $B\,A\,C$.

Letting $s = \dfrac{(R + R') + (R - \frac{1}{2}g + g') + (R' + \frac{1}{2}g)}{2}$

we have from trigonometry,

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R - \frac{1}{2}g + g')]\,[s - (R' + \frac{1}{2}g)]}{(R - \frac{1}{2}g + g')\,(R' + \frac{1}{2}g)}} \qquad (25)$$

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$s - (R - \frac{1}{2}g + g') = 764.694$	. . . .	2.8834877
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$R - \frac{1}{2}g + g' = 2865.576$	ar. comp.	6.5427881
$R' + \frac{1}{2}g = 766.194$	ar. comp.	7.1156612
Extracting sq. root	. . . .	2)19.9989215
$\frac{1}{2} B A C = 87° 08' 43''$	. . . . *sin.*	9.9994607

whence the angle $B' A C = 174° 17' 26''$ and the angle $D A E = 180° - 174° 17' 26'' = 5° 42' 34''$, the angle required.

To find the third or double-pointed frog angle $D A E$, fig. 24, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

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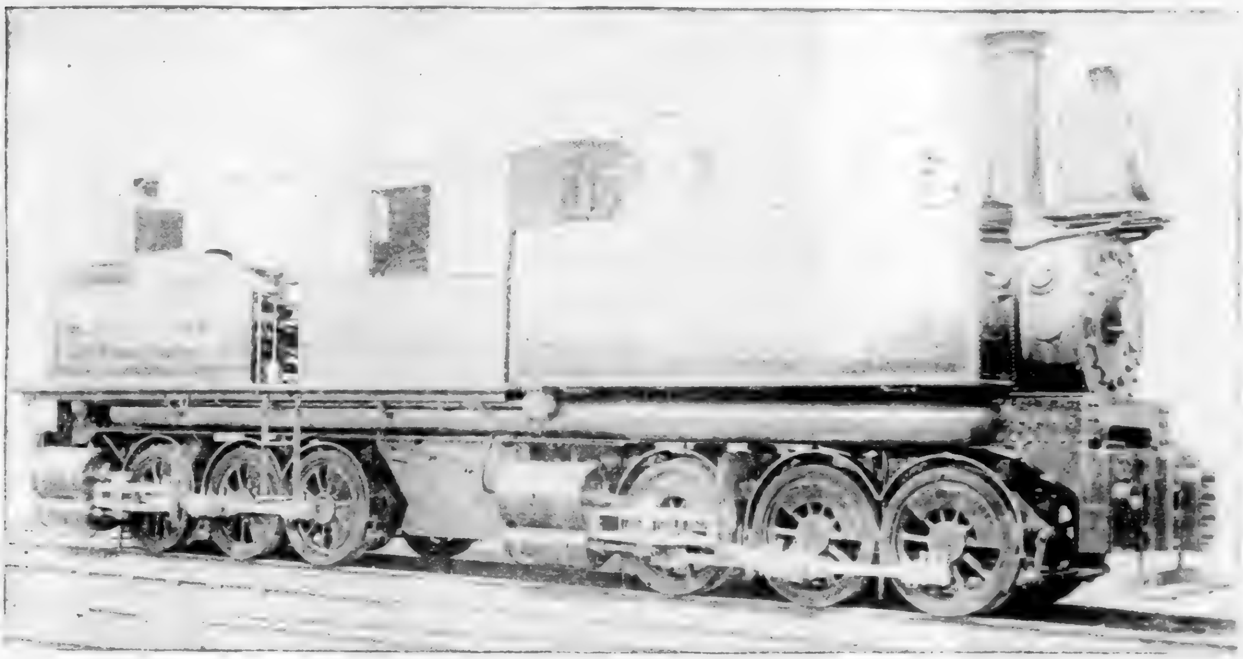

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Then from trigonometry

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preparing an exhibit intended to show the work done by its graduates in various parts of the world, as well as the work and methods of the Institute itself.

THREE traveling cranes, each of 20-tons capacity, are to be built for Machinery Hall. They will be used for moving heavy machinery into place before the opening, and will afterward be employed in carrying passengers from one end of the hall to the other in cars made for the purpose and lifted up from the floor. These cranes are to be operated by electric motors. They will be built by the Edge Moor Bridge Works, Wilmington, Del.; the Yale & Towne Manufacturing Company, Stamford, Conn.; and the Morgan Engineering Company, Alliance, O.

MISSOURI PACIFIC FREIGHT CAR TRUCK.

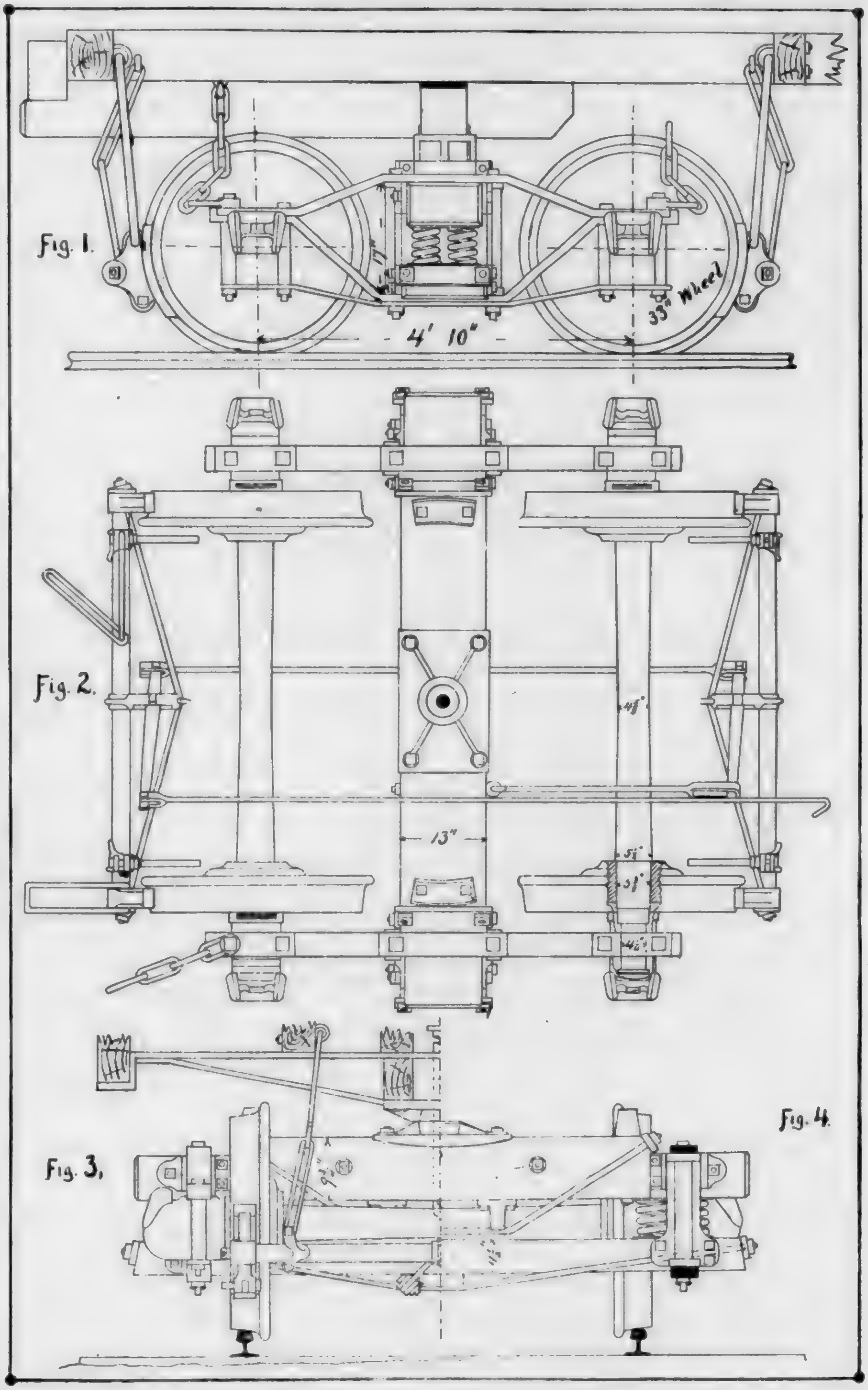
THE accompanying drawings show the standard freight car truck which the Missouri Pacific Company has adopted for its latest designs of freight cars, which are usually of 60,000 lbs. capacity. The drawings are so complete that little description is required.

The timbers are of white oak, the top bolster being 9¾ × 13 in., and 7 ft. 10 in. long, and the spring-plank 4½ × 13 in. and also 7 ft. 10 in. long. The journal-boxes are standard for 60,000-lbs. cars, and have the Hewitt lid. The axles are the M. C. B. standard, with 4¼ × 8-in. journals; they are 5⅜ in. diameter at the wheel-seat and 4⅝ in. at the center. The center plate is of malleable iron. The wheels are 33 in. in diameter and are spaced 4 ft. 10 in. between centers.

The National hollow brake-beam is used; and the arrangement of the brake gear is shown on the drawings.

The top arch-bar is 4 × 1¼ in.; the middle bar, 4 × 1⅛ in. and the tie-bar, 4 × ¾ in. The upper and lower truss-rods are respectively 1⅛ in. and 1 in. in diameter.

The truck is a very good design; it is based upon practice, and has done excellent service. It was designed under the direction of Mr. Frank Rearden, Superintendent of the Locomotive and Car Department, and is used for all classes of freight cars.



STANDARD FREIGHT CAR TRUCK, MISSOURI PACIFIC RAILROAD.

A HAWAIIAN TRESTLE BRIDGE.

WE are indebted to Mr. C. L. Wight, President and Manager of the Hawaiian Railroad, for the photograph from which the accompanying sketch has been prepared; it shows a trestle bridge built to carry a flume across a ravine on the Onomea sugar estate in the Hilo District in the Hawaiian Islands. The trestle was designed by Mr. William W. Goodale, Manager of the estate, and built under his charge.

The trestle is 157 ft. high above the bottom of the ravine at the center. The straight bents at the side are spaced 16 ft. apart; the span at the center, between the inclined bents, is 30 ft., and the other inclined bents are 20 ft. apart at the top. The span or opening between the two central inclined bents at the bottom is 140 ft.

The framing is exceedingly simple, and the work is all done by unskilled laborers and by carpenters having no knowledge of anything but the roughest work. No heavy pieces are required to be carried over a rough country, and there are no heavy weights to be raised. In erecting this trestle a watch-tackle was used, one double and one single sheave, a spar being run out from the completed bent to hoist the pieces for the next one.

The method of framing and bracing is shown in the sketch; the highest bent, 155 ft., has a spread of 40 ft. at the ground tapering up to 3 ft. at the top. The material used is native wood; for anything up to 50 ft., 3 × 4-in. scantling. For heights from 50 to 100 ft., for the lower 40 ft. 4 × 6-in. scantling, and for the balance 3 × 4-in.

are used. For bents over 100 ft. the lower 80 ft. are of 4 × 6-in. stuff, the rest of 3 × 4-in. All longitudinal braces are of 2 × 4-in. stuff; the cross-braces are 2 × 4 in. and 2 × 3 in. The method of bracing the inclined bents and the 30-ft. center span is shown in the sketch.

The flume which is carried over the ravine on this trestle is a trough 22 in. wide at the top, 12 in. at the bottom and about 12 in. deep in section. It is made of planks, the bottom one being 12 × 1¼ in., and the two side-planks 15 × 1¼ in. It is used, like the lumber flumes of California, not only for carrying water, but for floating other material. The flume has a grade of 15 in. in 100 ft., and when running nearly full of water will deliver at the mill from 20 to 25 tons of sugar-cane per hour from a field four miles distant.

This method of trestle-building was adopted by Mr. Goodale four years ago, replacing heavy truss construction and wooden arches; it has proved very successful, serving all purposes and diminishing the cost and labor of construction very much. It seems very well adapted for the purpose and for the place, and certainly reflects credit on the designer.

It may be added that the Onomea Estate is one of the largest and most successful in the Hawaiian Islands, the output of its mill being about 7,000 tons of sugar a year.

TRESTLE-BRIDGE AT ONOMEA, HILO, HAWAIIAN ISLANDS.

THE MEMPHIS BRIDGE.

THE great bridge over the Mississippi at Memphis was opened to public use on May 12 with appropriate ceremonies. It is the first bridge to cross the river below St. Louis, and is in itself a remarkable and noteworthy structure.

It has been built chiefly to connect the Kansas City, Fort Scott & Memphis road with its southeastern extension, the Kansas City, Memphis & Birmingham, but it also has connections with the other roads entering Memphis from the east and converging opposite that city on the Arkansas side. It carries a single-track railroad line, and the entire structure is some three miles.

The bridge proper is 2,597.1 ft. long in five spans, as follows: Eastern shore span, 225.8 ft.; main span, 790.4 ft.; two river spans, each 621.1 ft.; the western shore span, 338.7 ft.

The main span of 790 ft. is the longest truss span in this country and the third longest in the world, the opening being exceeded only by the 1,710-ft. spans of the Forth Bridge in Scotland, and the 820-ft. span of the Sukkur Bridge over the Indus in India.

The bridge is of the cantilever type. The eastern shore span is the anchor arm, 225.8 ft.; the main span is made up of two cantilever arms, each 169.4 ft., and an intermediate span suspended from the arms and 451.6 ft. long; the third span is a continuous truss 621.1 ft. long; the fourth span is made up of a cantilever arm 169.4 ft. and a truss span 451.6 ft. long, one end of which rests on the cantilever arm and the other on a pier; the western shore span is a deck truss of 338.7 ft.

There are five river piers, all of masonry built up on caissons sunk by the pneumatic process. The depths to which they were sunk to reach a solid bottom vary from 78 to 131 ft. below high water.

The trusses of the long spans are 77 ft. 8 in. in depth, and some idea of their size may be drawn from the fact that the main posts of the cantilever are 80 ft. in length and weigh about 28 tons each. The superstructure is of steel.

On the eastern or Tennessee bank the land is high and the bridge meets the bluff rising from the river. The approach tracks, however, are carried through the city of Memphis on an elevated structure 2,627 ft. long, composed of plate girders of 46 ft. span. On the western or Arkansas shore the land is low, and long approaches were required. These consist of a steel trestle or viaduct 2,290

LOCOMOTIVE RETURNS FOR THE MONTH OF FEBRUARY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	64	53	48,699	88,009	31,782	168,490	3,179	....	....	60.98	93.46	46.73	76.04	....	6.01	4.30	5.10	0.23	0.40	6.00	1.80	17.83	....	...	....
Alabama & Vicksburg	19	16	16,886	16,909	6,388	43,183	2,699	....	....	52.77	108 10	34.48	73.83	....	6.50	3.40	6.50	0.28	0.70	6.20	1.70	18.78	....	....	....
Atchison, Topeka & Santa Fé	707	591	....	....	297,473	1,884,990	3,189	....	....	...	....	....	83.65	....	....	6.25	6.84	0.28	0.18	6.25	1.57	21.37	....	...	1.55
Canadian Pacific	581	....	448,178	773,042	254,032	1,475,252	2,539	...	....	....	....	...	77.22	....	...	4.64	13.58	0.47	....	5 47	1.45	25.61	....	2.31	3.48
Central New England & Western	36	27	32,716	36,627	10,228	79,571	2,947	3.48	15.20	72.45	108.80	100.70	79.20	21.22	7.07	5.45	10.67	0.42	...	4.77	0.68	21.99	...	...	....
Chic., Burlington & Quincy	503	...	....	....	....	1,673,856	3,328	4.71	17.58	....	....	....	90.66	....	....	4.66	6.70	0.23	0.41	6.96	....	18.96	....	....	1.46
Chic., Milwaukee, & St. Paul	805	....	....	....	....	2,340,973	2,908	....	....	...	....	....	77.58	....	.	5.28	8.15	0.28	....	6.98	....	20.69	....	....	2.05
Chicago & Northwestern	846	....	618,630	1,217,457	559,659	2,395,740	2,832	....	....	....	....	....	88.69	....	...	3.77	8.24	0.37	....	7.15	....	19.53	....	....	1.84
Cincinnati Southern	106	92	74,299	173,606	66,046	313,951	3,413	...	...	76.33	125.00	48.90	97.66	...	7.46	3.40	6.40	0.26	0.60	6.60	1.60	18.86	...	....	....
Cleve., Cinn., Chic., & St. L.	....	445	391,202	613,549	331,850	1,336,601	3,004	4.30	21.00	78.06	126.18	73.65	99.05	18.20	6.01	3.01	6.46	0.19	2.02	6.55	0.24	18.47	....	....	1.30
Cumberland & Penn.	22	20	5,065	27,444	... .	32,509	1,625	....	....	....	....	....	90.91	....	...	8.34	5.10	0.40	...	....	2.10	15.94	....	...	....
D., L. & W., Main Line	207	197	....	....	... ...	614,239	3,118	....	....	...	....	....	90.58	....	....	3.49	6.77	0.38	....	6.12	....	16.76	....	....	....
Morris & Essex Div.	156	....	152,694	250,879	11,393	414,966	2,660	....	....	....	....	....	64.40	....	...	3.82	10.20	0.34	....	6.42	....	20.78	....	....	3.13
Hannibal & St. Joseph	44	43	40,656	80,247	23,725	144,628	3,287	4.76	16.13	...	....	....	87.26	14.57	6.97	3.82	5.56	0.14	0.34	6.72	....	16.58	....	....	1.41
Kan. City, F. S. & Mem	151	...	96,098	248,048	115,750	459,896	3,045	...	....	...	....	....	68.07	....	....	3.09	5.94	0.24	0.41	7.28	....	16.96	....	....	1.63
Kan. City, Mem. & Birm	41	38	34,674	60,573	10,292	105,539	2,777	....	....	....	...	....	68.54	....	....	3.18	4.55	0.77	....	6.85	....	15.35	....	....	1.29
Kan. City, St. Jo. & Council Bluffs	45	43	56,009	43,614	36,748	136,371	3,030	4.95	19.03	....	....	....	63.35	13 93	4.51	4.72	5.25	0.13	0.11	5.38	....	15.59	....	....	2.00
Lake Shore & Mich. South	575	....	413,359	925,038	543,017	1,881,414	3,272	..	....	63.96	89.89	36.40	68.80	...	....	3.14	5.48	0.13	0.06	7.13	0.17	16.11	....	....	1.85
Louisville & Nashville	....	*363	409,832	796,399	349,450	1,555,681	3,323	5.08	15.76	64.90	116.35	52.23	86.84	12.61	6.84	4.81	7.01	0.26	1.45	6.14	0.61	20.28	3.19	1.58	1.62
Manhattan Elevated	....	282	730,492	......	61,503	791,995	2,808	....	...	...	....	....	47.73	....	....	2.10	9.70	0.30	....	8.70	...	20.80	....	..	4.03
Mexican Central†	...	....	....	....	....	....	..	....	....	...	....	....	....	....	....	....	....	....	....	...	....	....	....	...	....
Mil., L. S. & West	112	98	71,067	159,015	68,941	301,023	3,072	....	....	....	....	....	76.42	....	....	3.79	13.41	0.16	....	6.32	0.89	24.57	....	...	3.00
Minn., St. Paul & Sault Ste. Marie	63	57	69,591	152,739	18,157	240,487	4,219	3.42	15.48	....	...	....	77.55	....	...	4.61	13.01	0.21	....	6.53	....	24.36	...	....	....
Missouri Pacific	339	308	....	....	....	1,112,135	3,611	4.43	17.64	...	....	....	93.26	19.45	6.16	5.20	6.64	0.35	1.31	6.63	1.44	21.59	4.80	1.36	1.40
N. O. & Northeastern	37	29	25,699	44,454	17,415	87,568	3,020	....	....	59.52	111.73	45.15	81.63	...	5.83	2.60	7.70	0.28	0.70	6.20	1.60	19.28	....	....	....
N. Y., Lake Erie & West	....	615	411,318	1,002,058	292,778	1,706,154	2,774	4.50	20.30	92.50	134.90	73.10	...	20.50	6.50	5.00	7.40	0.40	2.72	7.28	1.11	23.91	....	1.81	1.30
N. Y., Pennsylvania & Ohio	....	265	132,987	451,182	130,853	715,022	2,698	5.10	17.30	86.70	140.20	75.70	....	17.00	8.10	5.24	7.46	0.32	2.19	6 79	1.02	23.02	....	1.94	1.25
N. Y., Prov. & Boston	....	92	101,018	48,772	55,023	204,813	2,226	...	....	...	....	....	53.28	....	...	3.09	10.61	0.51	....	6.41	0.93	21.55	....	....	...
Old Colony	....	210	293,245	119,008	102,966	515,219	2,453	..	...	....	....	....	60.53	....	....	3.79	11.35	0.64	....	6.91	0.81	23.50	...	....	3.75
Philadelphia & Reading	....	...	419,514	795,268	528,925	1,743,707	....	...	....	....	....	....	87.22	....	...	4.74	4.79	0.33	...	5.76	0.40	16.02	...	....	...
South. Pacific, Pacific Sys.	...	....	....	.... . .	....	. ...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....
Union Pacific	992	....	668,852	1,157,281	472,760	2,298,893	2,307	5.48	15.63	....	....	....	104.90	16.17	9.26	7.73	10.65	0.46	0.92	8.09	1.20	29 05	4.83	2.37	2.00
Vicksburg, S. & P.	24	14	16,104	8,136	9,594	33,834	2,417	....	....	43.19	111.11	32.68	57.80	....	6.03	4.10	7.60	0.24	0.90	6.20	2.40	21.38	....	....	....
Wisconsin Central	156	136	122,258	241,239	53,582	417,079	3,067	....	....	....	....	....	88.61	....	....	3.73	11.02	0.26	....	7.34	....	22.35	.. .	...	2.44

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 16.6 units of work per $1 of expense; 172.4 units of work per ton of coal; 11.6 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

ft. long; a wooden trestle 3,097 ft.; a short embankment; then another trestle 290 ft. long, over the Little Rock & Memphis tracks, and finally an embankment 650 ft. long.

The bridge was designed by Mr. George S. Morison as Chief Engineer and built under his supervision, Mr. Alfred Noble being Resident Engineer. The contract for the masonry was taken by L. Ross, of Rochester, N. Y. The steel and iron work of the bridge was furnished by the Union Bridge Company and the Pencoyd Works of A. & P. Roberts. The viaduct approaches were built by Cofrode & Saylor and the Pennsylvania Steel Company. All the work was done under the specifications made by the Chief Engineer, and under his supervision.

The Berry & Orton Company.

THE publication of the engraving of an excellent machine manufactured by this Company gives a good text or occasion for the publication of some notes of a recent visit to their shops.

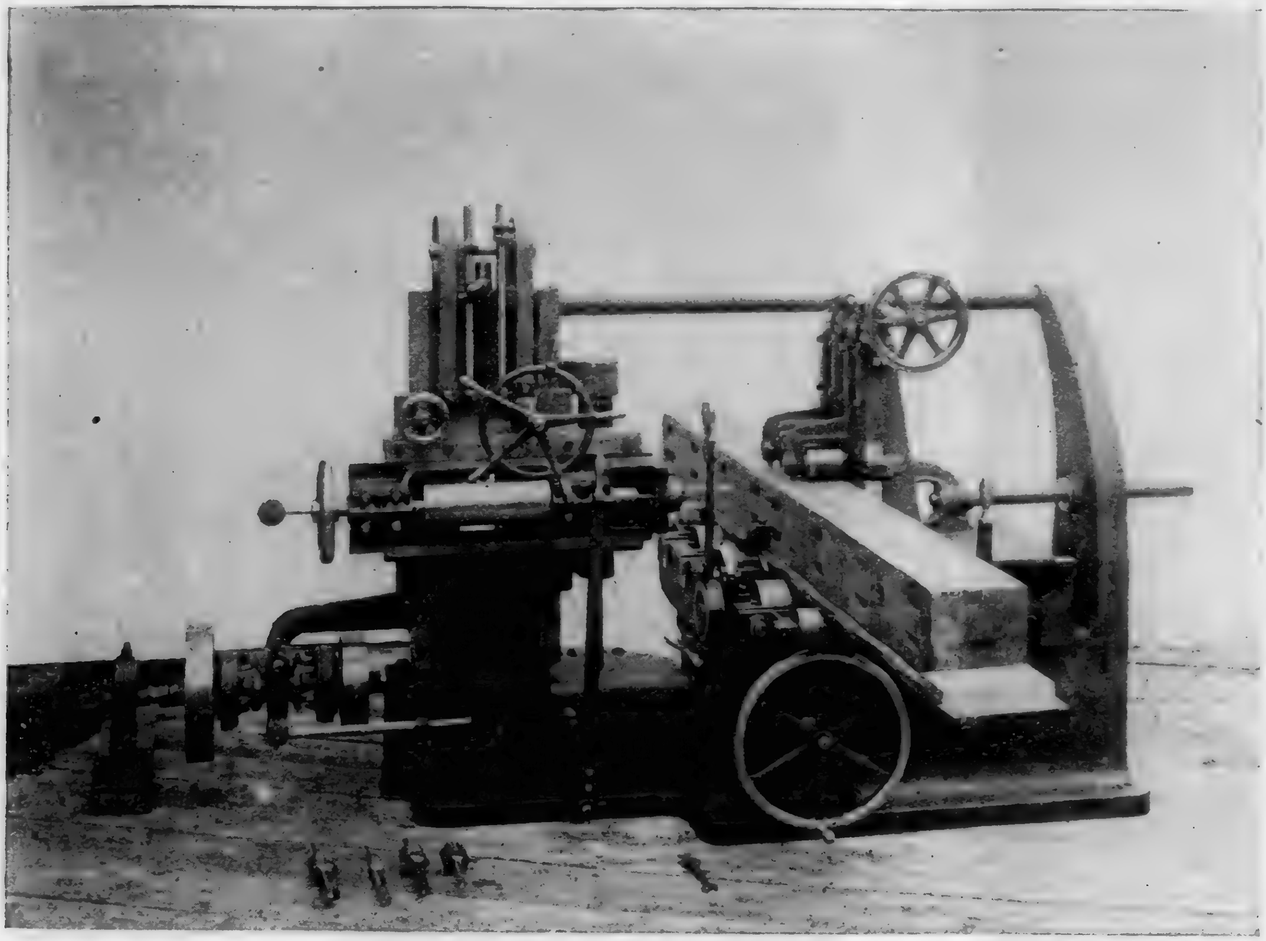
The Company is well housed in a four-story building on the corner of Twenty-third and Arch streets in Philadelphia. Its specialty is tools for working wood. Among these are band-saw machines, the manufacture of which is very interesting. The steel blades are made of Swedish steel imported specially for this purpose, and vary in thickness from No. 24 to No. 14 wire gauge and from $\frac{1}{16}$ to 12 in. in width. Some of the saws are as much as 54 ft. long. The steel when received here is properly tempered for use. The first step is to straighten the blades—that is, to take out any "kinks" that may exist. This is done by first rolling the blades and then hammering by hand. Any inequalities are detected by the reflection of light on the polished blade. The teeth are then punched out and afterward filed and set by a machine which works automatically. An ordinary three-cornered saw file is used in these machines which work in the most business-like and apparently intelligent way, and show not the slightest intention of striking for higher wages or shorter hours.

An interesting feature in the shop is the method of driving the shafting, of which there are two lines at right angles to each other on some or all of the floors. One of these lines is driven by a manilla rope consisting of 14 strands, four of which run over pulleys on each floor to drive the shafting on that floor.

The Company has provided well-appointed and comfortable offices and drawing-room, and all the floors of the shop are well lighted and warmed, and have the thrifty and prosperous appearance for which Philadelphia machine works are noted.

The engraving given is from a photograph of a hollow-chisel mortising machine made by the Company, and a comparison between it and the machines made some time ago for the same purpose will show the great advance and the many improvements secured in this class of tools.

The novelty of this machine consists of the peculiar formation of the chisel, which is square and is fitted with an auger made to revolve inside it. The end of the auger projects slightly beyond the edge of the chisel, and when presented to the timber it bores a round hole—the chisel following it and simultaneously squaring out the four corners and sides. Mortises of any length and width may be cut by forming a succession of square holes running into each other.



NEW HOLLOW CHISEL MORTISING MACHINE.

MADE BY THE BERRY & ORTON COMPANY, PHILADELPHIA.

It will be observed that with a machine of this kind the mortise is left clear of chips, and that tenoning and gaining can be done to good advantage.

The timber is clamped by friction rolls to a bed filled with heavy rollers which are driven in either direction by power or hand without releasing the clamp. This improvement increases the capacity of the machine about 50 per cent over the old way of releasing the timber and reclamping at each mortise. The oak piece shown in the engraving is designed for the end sill of a car and contains 16 mortises, which were cut without laying out in less than four minutes.

The cutting edges of the chisels are the matrix of a sphere and are readily sharpened by holding on an emery ball of the proper diameter. All machines are fitted with an arbor suitable to carry these, thereby reducing the cost of sharpening to a minimum.

The chisel is automatic in its movement or may be stopped at each stroke.

LOCOMOTIVE RETURNS FOR THE MONTH OF FEBRUARY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage: Passenger Trains	Freight Trains	Service and Switching	Total	Average per Engine.	Average Number of Cars in Trains: Passenger Cars	Freight Cars	Coal Burned per Mile: Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile: Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile: Passenger	Freight	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	[illegible]	53	48,[illegible]	[illegible]	[illegible]	168,490	[illegible]	...	...	[illegible]	[illegible]	[illegible]	76.0[illegible]		6.01	4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]	...		...
Ala. & Vicksburg	[illegible]	[illegible]	16,[illegible]	[illegible]	[illegible]	43,183	[illegible]	...	.	2.7[illegible]	[illegible]	[illegible]	73.[illegible]		6.5[illegible]	3.4	[illegible]	[illegible]	[illegible]	[illegible]	1.7[illegible]	1[illegible]	...	....	
Atchison, Topeka & Santa Fe	797	[illegible]	.....	....	[illegible]	[illegible]	[illegible]	.	...			.	[illegible]3.6	...	.	6.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.[illegible]	...		1.35
Canadian Pacific	5[illegible]1	...	1[illegible],17	[illegible]	[illegible]	[illegible]	[illegible]		...		..	...	7[illegible]2	.	...	4[illegible]	[illegible]	0.4[illegible]	...	5.47	1.[illegible]	25.6[illegible]		2.3[illegible]	[illegible]8
Central New England & Western	36	7	23,716	[illegible]	[illegible]	79,57[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		7	7[illegible]	21.[illegible]	7.[illegible]		[illegible]	1[illegible]	[illegible]4	.	4.77	0.[illegible]	21.9	..	..	....
Chic., Burlington & Quincy	593		...		...	[illegible]	3,[illegible]	1.71	17.[illegible]	...		..	[illegible]			4.[illegible]6	[illegible]	[illegible]	0.41	[illegible]6	...	18.[illegible]	..	.	1.[illegible]
Chic., Milwaukee & St. Paul	865		.	...	...	[illegible]	[illegible]	....	...	...	...	....	7[illegible]	.		5.[illegible]	[illegible]	[illegible]	.	[illegible]	.	20.6[illegible]	...	...	[illegible]
Chicago & Northwestern	[illegible]46		[illegible]	1,[illegible]	[illegible]	[illegible]95,74[illegible]	[illegible]	...	...			....	88.69	...	...	3.77	[illegible]	[illegible]	...	[illegible]	....	1[illegible].5[illegible]	...	...	1.84
Cincinnati Southern	1[illegible]	92	[illegible],299	17,[illegible]	[illegible]16	313,9[illegible]1	[illegible]		..	7[illegible]	5[illegible]	4[illegible].9	[illegible]6		7.4[illegible]	3.[illegible]	[illegible]	0.[illegible]	0.6[illegible]	[illegible]6	1.6	13.[illegible]	.	....	....
Cleve., Cinn., Chic. & St. L.	..	11[illegible]	[illegible]02	[illegible]	[illegible]	[illegible]6[illegible]1	[illegible]	4.[illegible]	21.[illegible]	7[illegible]	[illegible]6.1	7[illegible]5	9[illegible]	15.2[illegible]	6[illegible]	3.[illegible]	[illegible]	0.19	2.[illegible]2	[illegible]5	0.[illegible]	[illegible]7	.	.	1.[illegible]
Cumberland & Penn.	[illegible]	[illegible]	[illegible]65	[illegible]	...	32,5[illegible]	1,6[illegible]5	...	....	...	....	...	[illegible]	..	.	[illegible]	[illegible]	0.[illegible]	.	.	2.1[illegible]	1[illegible]	....	.	....
D., L. & W., Main Line	[illegible]07	1[illegible]7	...	....	...	614,239	3,[illegible]	..	....				[illegible]	...	..	3.4[illegible]	6.77	0.3	....	[illegible].12	...	1[illegible]7	....	.	....
Morris & Essex Div.	15[illegible]	.	152,6[illegible]4	50,[illegible]	[illegible]3	114,[illegible]66	2,[illegible]		....	...	...	...	[illegible]4.4[illegible]	.	...	3.[illegible]2	1[illegible]	0.[illegible]	...	[illegible]42	...	[illegible]7		.	[illegible]
Hannibal & St. Joseph	[illegible]	[illegible]	4[illegible]56	8[illegible],24[illegible]	[illegible]7[illegible]	144,623	3,[illegible]7	1.7	1[illegible]1	...	....	....	[illegible]7.2[illegible]	1[illegible]7	6[illegible]	3.[illegible]2	5.[illegible]	0.14	0.[illegible]	[illegible]7		1[illegible].5	...	...	1.4[illegible]
Kan. City, F. S. & Mem.	[illegible]	...	96,[illegible]8	4[illegible]8	115,75[illegible]	15[illegible]	3,[illegible]	..	...	...	....	..	[illegible]7	..	....	3.[illegible]9	5.[illegible]	0.[illegible]	[illegible].41	[illegible]2	...	16.9	..	.	1.[illegible]3
Kan. City, Mem. & Birm.	41	[illegible]	[illegible]4,07[illegible]	60,[illegible]7	[illegible]2	105,5[illegible]	2,777	....		.	...	...	[illegible].54	...		[illegible]	4.55	0.7[illegible]	...	[illegible]8	..	1[illegible].3[illegible]	.	....	1.[illegible]
Kan. City, St. Jo. & Council Bluffs	[illegible]	[illegible]	56,[illegible]	4[illegible]14	[illegible]6,73[illegible]	136,[illegible]71	3,[illegible]	[illegible]	[illegible]	.	...	...	[illegible]3.33	[illegible]	[illegible]	4.72	[illegible]2[illegible]	0.13	0.11	[illegible].3[illegible]	..	15.5[illegible]	..	...	2.[illegible]
Lake Shore & Mich. South	[illegible]		41[illegible]59	25[illegible]3[illegible]	51[illegible]17	1,8[illegible]1,414	[illegible]7	.	...	[illegible]	9.8[illegible]	36.4	[illegible].80	...	...	[illegible].14	5.46	0.1	[illegible].06	7.1	0.17	16.11	....	..	1.[illegible]
Louisville & Nashville	.	*[illegible]	[illegible]99,[illegible]32	796,[illegible]	349,[illegible]	1,555,[illegible]	3,[illegible]23	[illegible]	15.76	[illegible]4.[illegible]	116.35	52.23	[illegible]6.[illegible]4	12.61	[illegible]4	4.[illegible]	7.01	0.[illegible]6	1.4[illegible]	6.14	0.61	[illegible]2[illegible]	3.1[illegible]	1.[illegible]	1.62
Manhattan Elevated	....	2[illegible]2	7[illegible]0,49[illegible]	...	[illegible]1,5[illegible]	7[illegible]	[illegible]	.	.	.	....	....	17.7[illegible]	....	...	[illegible]	[illegible]	0.[illegible]	....	[illegible].70	...	2[illegible].80	...	.	4.[illegible]3
Mexican Central†	.		....	....	....	....	..	.	.	.	....	....	...	.	....	...	....	....				...	...	...	...
Mil., L. S. & West.	11[illegible]	[illegible]	7[illegible],067	15[illegible],01[illegible]	68,941	301,023	3,[illegible]	....	...	....	....	...	7[illegible].42	....	...	3.79	13.41	0.16	....	6.[illegible]3	[illegible].89	21.57	...	...	3.00
Minn., St. Paul & Sault Ste. Marie	63	[illegible]	[illegible]9,591	152,7[illegible]	[illegible]8,157	[illegible]4[illegible],487	4,[illegible]	[illegible].32	1[illegible].4	....	..	....	77.55	...	..	4.[illegible]1	13.[illegible]1	0.[illegible]1	...	[illegible].53	....	24.3[illegible]	..	....	...
Missouri Pacific	[illegible]39	30[illegible]	...	......	....	1,112,135	3,[illegible]11	4.[illegible]3	17.64	...	....	...	[illegible]2	1[illegible].45	6.16	5.2[illegible]	6.64	0.[illegible]	1.31	6.63	1.44	21.5	1.[illegible]	1.3[illegible]	1.4
N. O. & Northeastern	37	[illegible]	2[illegible],6[illegible]	44,451	17,41[illegible]	7[illegible],563	3,[illegible]	..	....	5[illegible].52	111.73	45.1	[illegible]1.63	..	5.83	2.60	7.7[illegible]	0.2[illegible]	0.70	[illegible].20	1.6[illegible]	1[illegible].2[illegible]	....	....	....
N. Y., Lake Erie & West.	...	[illegible]1	111,315	1,0[illegible]8	[illegible]77[illegible]	1,[illegible]6,154	2,771	4.59	2[illegible].30	92.5[illegible]	1[illegible]	73.1[illegible]	...	2[illegible].59	6.50	5.[illegible]	7.49	0.4	2.72	7.28	1.11	2[illegible].91	....	1.81	1.30
N. Y., Pennsylvania & Ohio		[illegible]	1[illegible]87	45[illegible],1[illegible]2	1[illegible]3	715,022	2,6[illegible]	5.1	17.3	86.7	14[illegible].2[illegible]	75.7	....	17.[illegible]	8.10	5.24	7.4[illegible]	0.[illegible]	[illegible]	6.79	1.[illegible]2	2[illegible].0[illegible]	...	1.[illegible]4	1.25
N. Y., Prov. & Boston	[illegible]	[illegible]	101,01[illegible]	48,77[illegible]	55,02[illegible]	[illegible]4,513	2,2[illegible]6	..	...	...	....	....	[illegible].2	..	..	[illegible].09	1[illegible].61	0.51	....	[illegible].41	0.[illegible]	21.55	...	....	...
Old Colony		21[illegible]	[illegible].24[illegible]	11[illegible],005	1[illegible]66	515,219	2,453	..	...	....	....	....	[illegible].5[illegible]	..	...	[illegible].79	11.35	0.64	....	6.91	0.81	[illegible]3.50	..	....	3.75
Philadelphia & Reading		..	1[illegible]9,5[illegible]4	7[illegible],268	[illegible]8,925	1,713,707	....	...	....	...	....	....	[illegible]7.22	....	...	4.74	4.79	0.[illegible]3	..	5.7[illegible]	0.4[illegible]	1[illegible].02	...	....	..
South. Pacific, Pacific Sys.	.	...	.....	.	...	....	...	....	...	....	...	....	....	....	....	..	....	....	....	....	....	..	...	...	....
Union Pacific	.	....	6[illegible]52	1,15[illegible],2[illegible]1	472,76[illegible]	2,29[illegible],[illegible]93	2,3[illegible]7	5.4	1[illegible].6	....	...	....	[illegible]	1[illegible].17	9.2[illegible]	7.73	1[illegible].65	0.4[illegible]	0.92	[illegible].09	1.[illegible]	2[illegible].95	4.83	2.37	[illegible]
Vicksburg, S. & P.	[illegible]4	14	16,104	8,1[illegible]6	9,5[illegible]4	3[illegible],834	2,417	....	....	43.1[illegible]	111.11	3[illegible].68	[illegible]7.[illegible]	....	6.[illegible]	4.10	7.60	0.[illegible]4	0.[illegible]	6.2[illegible]	2.40	21.38	....	....	....
Wisconsin Central	1[illegible]6	1[illegible]	12[illegible],25[illegible]	[illegible]41,[illegible]9	53,5[illegible]2	417,07[illegible]	[illegible]67	....	....	....	...	....	8[illegible].61	....	....	3.73	11.[illegible]2	0.26	....	7.[illegible]4	...	22.35	...	...	2.44

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of [illegible] cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 16.6 units of work per $1 of expense; 172.4 units of work per ton of coal; 11.6 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

ft. long; a wooden trestle 3,097 ft.; a short embankment; then another trestle 290 ft. long, over the Little Rock & Memphis tracks, and finally an embankment 650 ft. long.

The bridge was designed by Mr. George S. Morison as Chief Engineer and built under his supervision, Mr. Alfred Noble being Resident Engineer. The contract for the masonry was taken by L. Ross, of Rochester, N. Y. The steel and iron work of the bridge was furnished by the Union Bridge Company and the Pencoyd Works of A. & P. Roberts. The viaduct approaches were built by Cofrode & Saylor and the Pennsylvania Steel Company. All the work was done under the specifications made by the Chief Engineer, and under his supervision.

The Berry & Orton Company.

THE publication of the engraving of an excellent machine manufactured by this Company gives a good text or occasion for the publication of some notes of a recent visit to their shops.

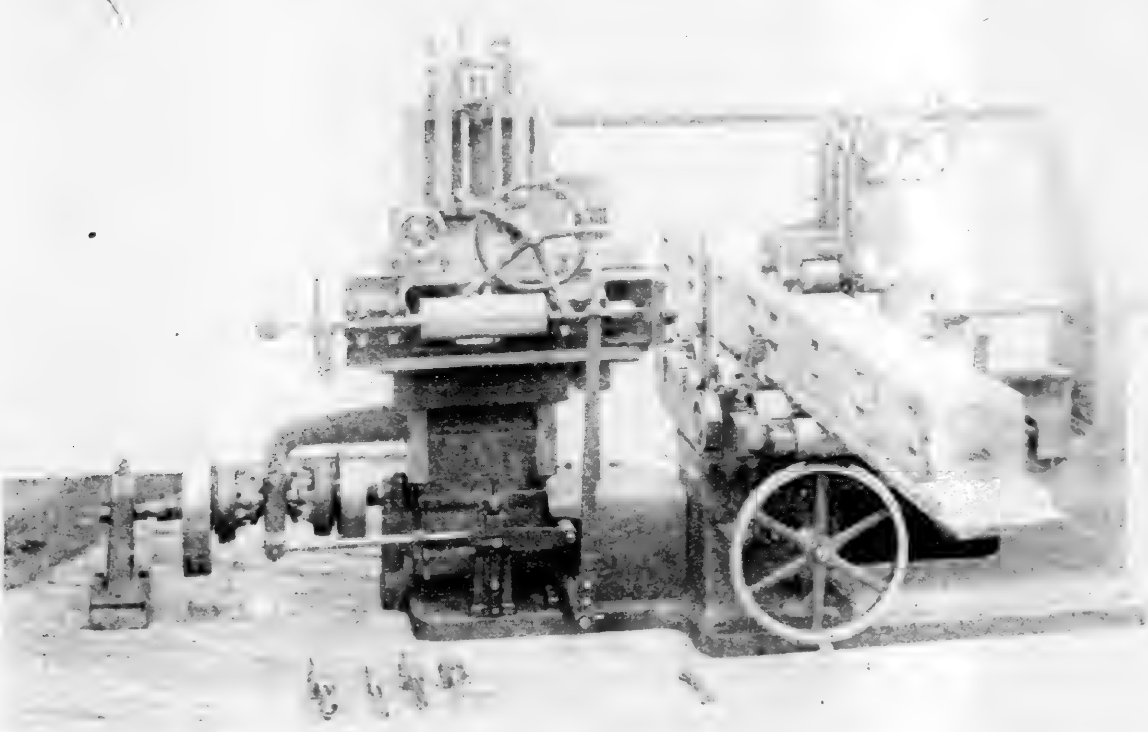
The Company is well housed in a four-story building on the corner of Twenty-third and Arch streets in Philadelphia. Its specialty is tools for working wood. Among these are band-saw machines, the manufacture of which is very interesting. The steel blades are made of Swedish steel imported specially for this purpose, and vary in thickness from No. 24 to No. 14 wire gauge and from $\frac{1}{16}$ to 12 in. in width. Some of the saws are as much as 54 ft. long. The steel when received here is properly tempered for use. The first step is to straighten the blades—that is, to take out any "kinks" that may exist. This is done by first rolling the blades and then hammering by hand. Any inequalities are detected by the reflection of light on the polished blade. The teeth are then punched out and afterward filed and set by a machine which works automatically. An ordinary three-cornered saw file is used in these machines which work in the most business-like and apparently intelligent way, and show not the slightest intention of striking for higher wages or shorter hours.

An interesting feature in the shop is the method of driving the shafting, of which there are two lines at right angles to each other on some or all of the floors. One of these lines is driven by a manilla rope consisting of 14 strands, four of which run over pulleys on each floor to drive the shafting on that floor.

The Company has provided well-appointed and comfortable offices and drawing-room, and all the floors of the shop are well lighted and warmed, and have the thrifty and prosperous appearance for which Philadelphia machine works are noted.

The engraving given is from a photograph of a hollow-chisel mortising machine made by the Company, and a comparison between it and the machines made some time ago for the same purpose will show the great advance and the many improvements secured in this class of tools.

The novelty of this machine consists of the peculiar formation of the chisel, which is square and is fitted with an auger made to revolve inside it. The end of the auger projects slightly beyond the edge of the chisel, and when presented to the timber it bores a round hole—the chisel following it and simultaneously squaring out the four corners and sides. Mortises of any length and width may be cut by forming a succession of square holes running into each other.



NEW HOLLOW CHISEL MORTISING MACHINE.
MADE BY THE BERRY & ORTON COMPANY, PHILADELPHIA.

It will be observed that with a machine of this kind the mortise is left clear of chips, and that tenoning and gaining can be done to good advantage.

The timber is clamped by friction rolls to a bed filled with heavy rollers which are driven in either direction by power or hand without releasing the clamp. This improvement increases the capacity of the machine about 50 per cent over the old way of releasing the timber and reclamping at each mortise. The oak piece shown in the engraving is designed for the end sill of a car and contains 16 mortises, which were cut without laying out in less than four minutes.

The cutting edges of the chisels are the matrix of a sphere and are readily sharpened by holding on an emery ball of the proper diameter. All machines are fitted with an arbor suitable to carry these, thereby reducing the cost of sharpening to a minimum.

The chisel is automatic in its movement or may be stopped at each stroke.

Foreign Naval Notes.

A NEW submarine boat has been designed by a Portuguese engineer, Dom Fontes Pereira de Mello, which is described as possessing several novel features. The boat has a length of 72 ft., a diameter of 11 ft. 2 in., and a displacement when submerged of 100 tons. Power is furnished by a motor working from accumulators, which drive a pair of screws and give a speed of six knots, maintainable for 14 hours.

The boat is submerged by introducing water ballast into reservoirs, and by horizontal propellers, its perfect stability under all conditions being insured by a special arrangement. When submerged, direct communication is kept up with the outer air by means of long hose, which admits of 40 cubic meters of air per hour, and allows the free respiration of natural air. The dome is furnished with an optical tube 16½ ft. long and slightly over 4 in. in diameter, within which a set of mirrors reflect the image of the object to be observed, and magnify it before it meets the eye of the observer.

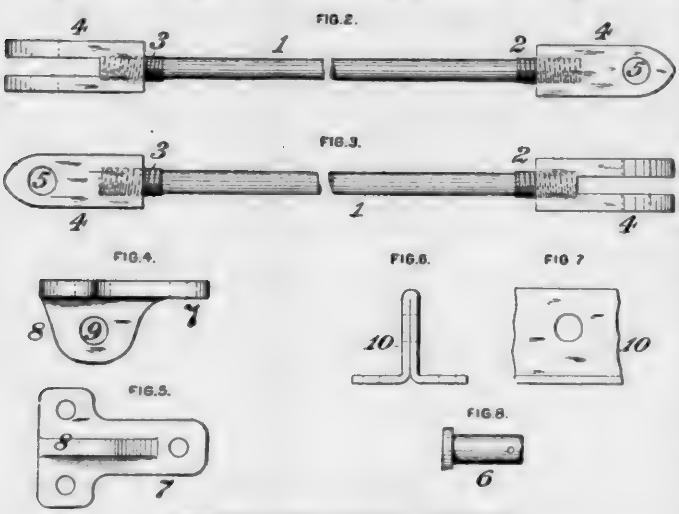
The special advantages claimed for the new boat over all others are: Its absolute stability, even when submerged in a strong current; free respiration, without the necessity for reservoirs of compressed air, and consequent ability to remain under water for lengthened periods; and, finally, the special optical apparatus which permits of a good lookout being kept.

Recent Patents.

WIGHTMAN'S BOILER BRACE.

THE accompanying drawings, figs. 2–8, show an improvement in boiler-braces covered by Patent No. 473,183, recently issued to Mr. D. A. Wightman, of Pittsburgh, Pa. The nature of the invention will be readily seen from the drawings, and the advantages over braces of the ordinary welded form will be appreciated.

In practice the ends of a rod 1, of suitable diameter and length for the service required, are upset or increased in diameter, and screw-threads 2, 3, which are preferably, as shown, of opposite lead—that is to say, right and left handed, respectively—are cut upon said ends. The heads 4 of the brace, which may be of similar form, are preferably made by drop-forging, and eyes 5 are formed in said heads to receive coupling bolts or pins 6. An internal screw-thread is cut upon each head at and near the end furthest from its eye 5, the threads of the two heads of each brace being in correspondence with those of the



WIGHTMAN'S BOILER BRACES.

ends of the rod 1 which they are designed and adapted to engage. In the instance shown the heads 4 are bifurcated, an eye being formed in each of their jaws, which are adapted to embrace a projection upon a fixed bearing-piece; but if preferred, they may have only a single tongue or plate adapted to fit between jaws on a bearing-piece. The bearing-pieces or ties by which the braces are connected to the boiler-shell and heads or ends may be of any suitable form adapted to be firmly secured to the boiler and to present a proper bearing for the reception of a connecting or coupling pin.

Figs 4 and 5 show a bearing-piece suitable for attachment to curved portions of the shell, the same consisting of a foot 7, in which are formed a proper number of rivet-holes and which has a projecting lug 8, adapted to fit freely between the jaws of a brace-head 4 and provided with an eye 9 to receive a coupling-pin 6. Figs. 6 and 7 show a bearing-piece 10 substantially of the form ordinarily used on the flat ends or heads of boilers, the same being a plate bent into T-section and provided with coupling-bolt eyes. If preferred, T-iron of proper strength may be substituted, the special form of these and of the shell bearing-pieces not forming any part of my present invention.

In practice the bearing-pieces or ties are riveted to the shell in their several desired positions by a riveting-machine while the shell is being put together, after which it is only necessary to put the braces in position, insert the coupling-pins, and draw the braces to their proper degree of tightness by turning the rods 1, and thereby screwing the heads 4 into their proper positions on the screw-threads of the rods.

It will be seen that this improved brace has no welds, and may be made altogether by machinery. In its application absolute uniformity of tension of the several braces may be secured, a result of substantial practical importance and value which is impossible with the ordinary brace, and it has been found in actual use that the entire labor on this improved brace is less than either the blacksmith's or the boiler-maker's labor on the ordinary brace.

A Car-Wheel Boring Mill.

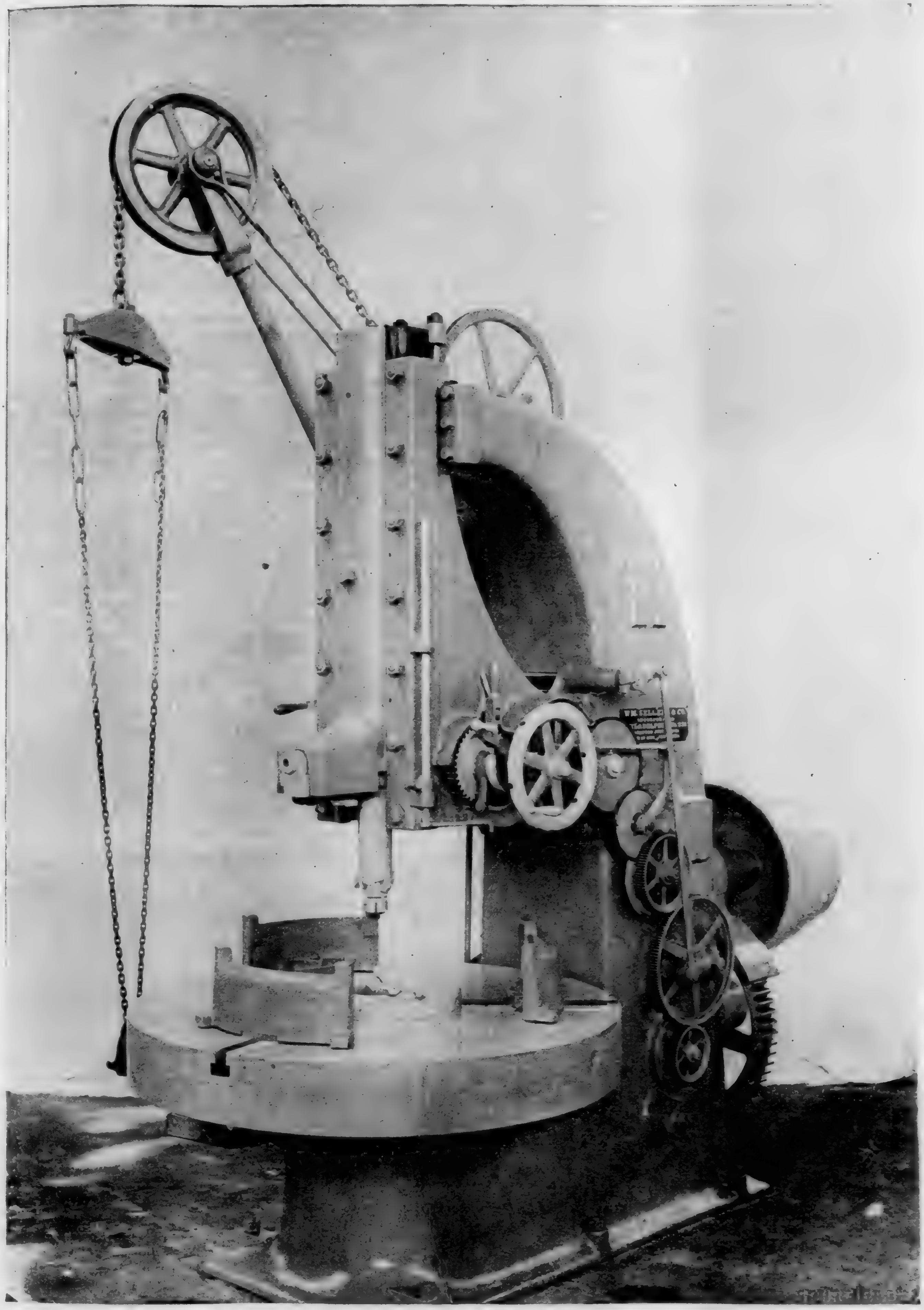
THE evolution of the car-wheel boring mill has developed in general along the same lines, and the result is a type of machine in which the products of the various makers are in the main identical, differing generally in minor features only.

The illustration given herewith is from a photograph of one of the latest machines of the class under notice, a 50-in. boring mill built by William Sellers & Company, of Philadelphia. Among the points which are peculiar to this machine may be noted, first, the *Table;* this is provided with a self-closing universal chuck—that is, starting the table causes the chuck to close upon the work and hold it securely. Stopping the table compels the chuck to open so as to release the work. The chuck has three slides, each carrying a swiveling jaw of cast steel, and each jaw has two gripping points, so that the wheel is practically held and centered by six points. Repeated stopping and starting of the table does not disarrange the work, as the jaws close each time to the same place. The table is carried upon a flat bearing ring, is centered by a hollow spindle, and is driven by a steel bevel pinion engaging with teeth upon the under surface of the table. For stopping the table a clutch arrangement is provided, by means of which the table may be stopped or started instantly and without shock by the simple movement of a hand lever. These two features, the self-closing chuck, and the instantaneous stopping of the table, are radical departures from any of the prototypes of this machine and contribute largely to increase product.

The boring bar is provided with four cutting edges, the cutters being secured in the bar by a very simple locking device, which greatly facilitates the work of changing cutters. The bar is carried on the end of a slide of large section and great length which is counterbalanced by a weight hanging in the frame of the machine. It is provided with a rapid hand adjustment and an adjustable friction feed, which will give any amount of feed required, from a fine roughing-cut to a ⅜ finishing feed. The lever for regulating the feed is provided with an automatic latch which secures it in any position, so that in adjusting the amount of feed, it is only necessary to push the lever to the point desired, as when released it will remain where placed. The friction feed is engaged and disengaged by a hand lever with a spring latch operating a toothed clutch which can be engaged in any position, thus giving positive command of the feed, so that there is no danger of the apparatus becoming jammed, as sometimes happens with devices employing friction clamps of various sorts. There is also a facing rest, for the ends of hubs, situated on the end of the slide, which is brought into position for cutting after the boring cutters pass through the wheel.

Another feature of this machine is the crane attachment. This is driven by friction gearing within the machine, and holds the load automatically suspended at any point. It is also arranged to stop automatically when the top or bottom of the lift is reached. The operator, when putting a wheel in place, starts the hoist with one hand and then uses both hands to steady the wheel. When the top of the hoist is reached the crane stops. The wheel is then swung into position and a reverse movement of the handle starts it to lowering, while the operator has both hands free to guide the wheel into the chuck. The handles for controlling the machine are all gathered together in one place, where they can be conveniently reached by the operator as he stands directly in front of the machine.

The table is 50 in. in diameter and the chuck will take a 42-in. wheel. There are two speeds for the countershaft and the gearing is exceptionally powerful. The machine may be considered the latest development of its class, with all the improvements which experience has shown to be desirable.



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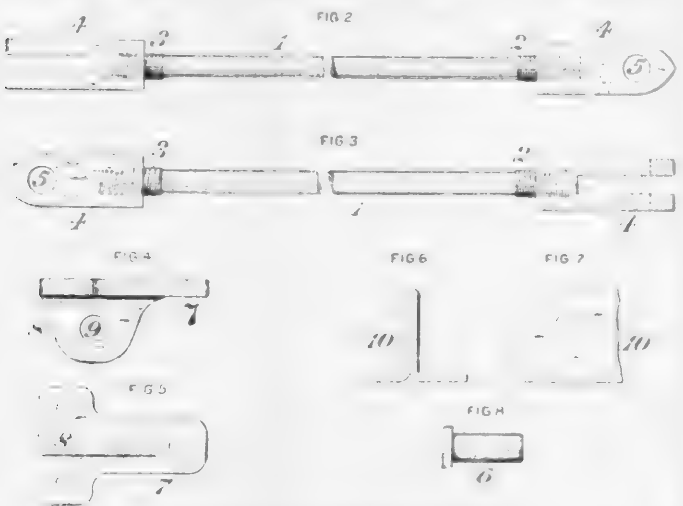

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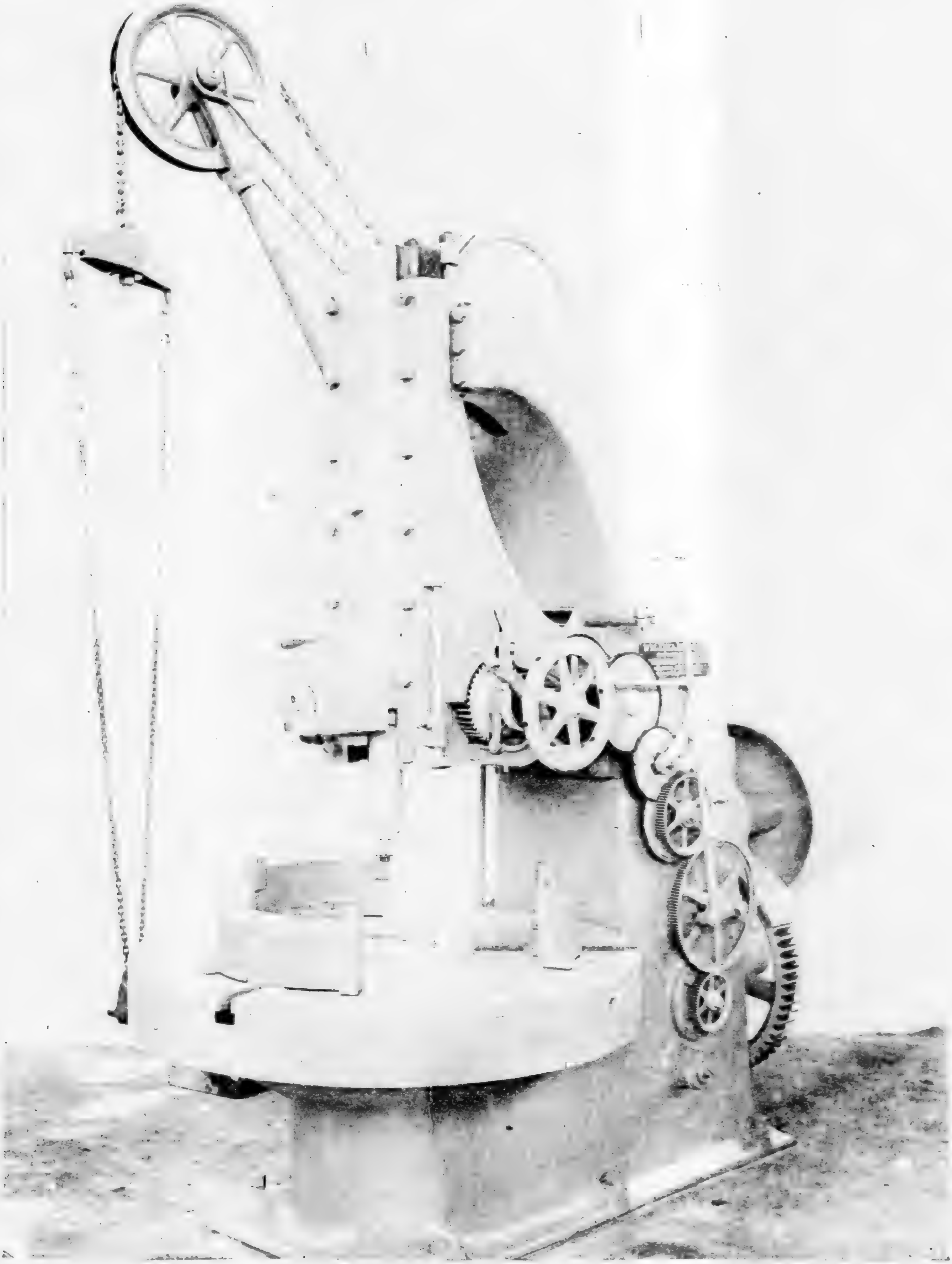


50-INCH CAR-WHEEL BORING MILL.
MADE BY WILLIAM SELLERS & COMPANY, PHILADELPHIA.

Manufactures.

General Notes.

THE National Varnish Company, New Haven, Conn., besides its ordinary business with carriage and wagon makers, supplies all the varnishes used on the passenger cars of the New York, New Haven & Hartford Railroad. Its varnishes are also used on the cars of the Brighton Beach Railroad, and on the railroad cars built for the use of the Barnum & Bailey Circus, as well as on the chariots and wagons of that circus.

THE Portchester Bolt & Nut Company, Portchester, N. Y., is building an addition to its works, the present quarters being too small for the increasing business. The new building is 50 × 100 ft., three stories high, frame, with gravel roof, and will be used for offices, packing-rooms and storage-rooms.

THE Rhode Island Locomotive Works in Providence recently completed for the Maine Central Railroad two six-wheeled switching engines with 18 × 24-in. cylinders, and two Mogul freight engines with 19 × 24-in. cylinders.

THE patent mandrel-rolled hollow stay-bolts made by the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., are being used in several new locomotives which the Brooks Locomotive Works are building for the Lake Shore & Michigan Southern road. The same stay-bolts are also required by the specifications to be used in 100 locomotives recently ordered by the New York Central & Hudson River Railroad from the Schenectady Locomotive Works.

THE Rogers Locomotive Works, Paterson, N. J., are building 25 ten-wheel and 25 mogul engines for the Chicago, Burlington & Quincy Railroad.

THE Cleveland, Columbus, Cincinnati & St. Louis Company recently placed orders for 50 new locomotives. Of these 10 will be built by the Schenectady Locomotive Works; 10 by the Brooks Locomotive Works at Dunkirk, N. Y.; and the remaining 30 by the Richmond Locomotive Works, Richmond, Va.

THE premises of the Harrisburg Foundry & Machine Works, Harrisburg, Pa., extend over about 22 acres, 6 acres of which are covered by the existing buildings, which will shortly be increased by the addition of a large warehouse for storage of the various portions of the standard sized engines manufactured at the works, of which a considerable stock will be carried, so that on receipt of orders for engines the different parts can be withdrawn and fitted together with the least possible delay. An addition of 90 ft. is also to be made to the foundry, which will double its capacity. The offices have also been lately expanded by the erection of a new wing, which enlarges the drawing-room and provides a directors' room and several additional offices. The directors' room is thrown open as a reading-room for the employés out of working hours, and is well provided with trade journals and other publications. The departments in the works are two machine shops, a pattern shop, foundry, smith shop, boiler shops, wood-working department, road-roller department, grinding shop, testing shop, a large warehouse for finished goods and a pattern storehouse. Besides steam-engines and boilers, a large number of steam road-rollers are made. The testing department is a most important factor in the works, and is fitted with an excellent arrangement by which any number of engines up to eight can be steam tested simultaneously to any required pressure. All the engines made are fitted together here, and thoroughly tried before being shipped.

THE Pullman Car Works, Pullman, Ill., have a great deal of work on hand, including 100 passenger cars for the Philadelphia & Reading; 25 for the Norfolk & Western; 22 for the Southern Pacific; 20 for the Chicago, Rock Island & Pacific; 6 parlor cars for the Chicago & Northwestern, and a number of smaller orders. The freight shops are building 400 coal and 1,000 box-cars for the Norfolk & Western Railroad.

THE United States Rolling Stock Company will be reorganized as the United States Car Company. The new concern will issue $3,500,000 stock and $4,000,000 bonds.

AT the recent annual meeting of the American Steel Wheel Company, Mr. J. H. Olhausen was elected Vice-President, and Mr. Samuel Garwood, Secretary and Treasurer. It was also decided to remove the Secretary and Treasurer's office from Boston to the general offices of the Company, New York City.

THE Mt. Vernon Car Manufacturing Company, Mt. Vernon, Ill., is building 300 flat cars for the Evansville & Terre Haute and 200 box-cars for the Mobile & Ohio Railroad.

THE Short Electric Railroad Company has a contract to equip the street railroad line at Bangkok, Siam, for working by electricity. The line, which is of 30-in. gauge and about 6½ miles long, is now operated by mule power and does a very good business. The electric plant includes an engine, two generators of 65 H.P. each and six cars with motors of 20 H.P. each.

THE Jones Brothers Electric Company in Cincinnati is making a model 20 × 50 ft. in size for the Columbian Exposition. It will show the extensive plant of the Frick Coal & Coke Company in Western Pennsylvania, with trains, engines, etc., in motion; it will be worked by electricity.

The Bell Spark Arrester.

THE locomotive spark arrester devised by Mr. J. Snowden Bell, of Pittsburgh—which was described and illustrated in the JOURNAL for March, 1890—has, we are informed, recently had a careful test on an engine of the Wisconsin Central road, with such favorable results that it has just been fitted on a new 19 × 24-in. cylinder Mogul engine for further use. A number are in use on the Mexican Central, and all the engines of that road are to be fitted with Mr. Bell's device. It is also in use on the Southern Pacific lines, several engines having been fitted up at the Sacramento shops, and it is shortly to receive a thorough test on the Pennsylvania Railroad.

Tests of Hollow Stay-Bolts.

SOME specimens of hollow stay-bolt iron made by the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., have just been tested at the Physical Laboratory of Washington University in St. Louis, and the results are reported as below by Professor J. B. Johnson:

"Size of tested section, 0.895 in. diameter and 10½ in. long, with $\frac{3}{16}$-in. hole at center; area of section, 0.601 sq. in. Broke at 29,600 lbs.; breaking strength per square inch, 49,200 lbs.; limit of elasticity, 17,000 lbs.; limit of elasticity per square inch, 28,300 lbs.; elongation of reduced section in 5 in., 1.7 in.; per cent. of elongation, 34; area of reduced section, 0.30 sq. in.; per cent. of reduction in section, 50.

"This is a remarkably fine specimen of wrought iron for stay-bolt purposes. Its elongation, 34 per cent., is the greatest I have ever found for wrought iron, and this is of the utmost importance in stay-bolt iron. The fracture shows a pure, fibrous, unlaminated and uncrystalline structure."

The Empire Car Coupler.

THE drawings given herewith show a new coupler which has been worked out by practical railroad men, and which, it is claimed, fills completely the requirements of the M. C. B. type. It is also claimed that it meets all the requirements of an automatic safety coupler, entirely preventing risk to the trainman. In the drawings figs. 1 and 2 show an elevation and plan of a coupler; fig. 3 is a section on the line *A C*, fig. 2; figs. 4 and 5 show the coupler in section; fig. 6 is a front view; figs. 7 and 8 show respectively an end view and a side elevation of a car provided with the coupler.

In this coupler extraordinary strength is secured by providing from 5 sq. in. to 6 sq. in. of locking surface, and by the knuckle engaging with the side and end of the draw-head in such a manner as to almost entirely relieve the pin from either buffing or pulling strains. Under this construction a small pin is used, allowing for more material in the knuckle and the jaws of the draw-head. The draw-bars will be manufactured from the best quality of malleable iron, and the knuckles from a grade of steel which has earned a high reputation in such work.

Next to strength it is required for a coupler that the mechanism must be such as will not get out of order, and can be easily operated under all conditions of the freight train service. The Empire coupler proper is composed of but three parts, the knuckle-opening device being a part of the unlocking device. The unlocking and knuckle-opening device is completely enclosed within the shell of the draw-bar, and is protected thereby from the elements and foreign substances; it is impossible for this coupler to freeze up. On account of the increased leverage provided for unlocking, it is believed that it will never be necessary to take slack for uncoupling. It is claimed that the

coupler can be uncoupled under a greater strain than any one yet introduced, which is an important consideration in the switching service of a large yard.

The draw-bar of the M. C. B. type of coupler being so large that the safety of the train is imperiled in case it should be dropped upon the track through the breakage of a tail-pin or the snapping off of the head, provision should be made against such contingencies. This has been accomplished in this coupler by a chain attached to the unlocking device and the end sill of the car, so that when the draw-bar should be moved forward after breakage of the tail-pin the knuckle will be unlocked. Or, if the head of the draw-bar should be broken off, the same chain, together with the chain attached to the unlocking lever, will prevent it from dropping to the track.

It is well understood by the operating officials that one great cause of damage to car equipment is the failure of men to be on top to apply the brakes when switching. Cars are uncoupled from the ground and kicked into sidings, and before men can climb to the top to set the brakes collisions occur with other cars and damage results. Therefore, a coupler, to fully meet the requirements of the service, must be of such design that it can be operated from the top of the car as well as from the ground, so that the brakemen will be in position to set the brakes immediately when necessary. This coupler meets this requirement, since it can be operated from the top of either side of the car with equal facility.

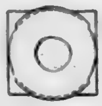
The above are the essential features of any car coupler viewed from an operating standpoint; but the M. C. B. coupler must be even more than this. It must be an *automatic safety* coupler under all conditions of service. Safety requires that men should never go between the cars to couple or uncouple them, or to put the coupler in position for coupling, under any circumstances. A careful examination of the drawings herewith will show how far the coupler will bear out the claim that it is a positively automatic safety device, meeting all the requirements of actual service.

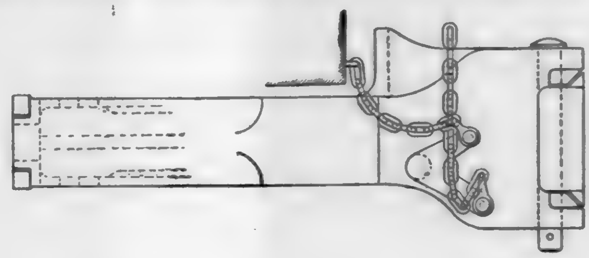
' Full-size couplers set up in working order can be seen at the office of the Empire Car Coupler Company, 15 Warren Street, New York City.

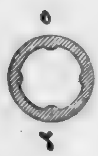
Baltimore Notes.

CONTRACTS have been awarded to the Campbell-Zell Company, of Canton, for boilers to be placed in the power-houses of the City Passenger Railroad on Baltimore and Eutaw streets, to serve the cables of the Red and White Lines. The contracts for the wheel range for the cables were awarded to the Pennsylvania Steel Company, at Steelton. President Bowie says the work of cabling these lines will now progress rapidly. He attributes much of the set-backs to the fact that the work was commenced on Friday. President Bowie does not admit that he is superstitious, but says that he would never begin any work on Friday. E. B. Smith & Company, the contractors for

Fig. 1.







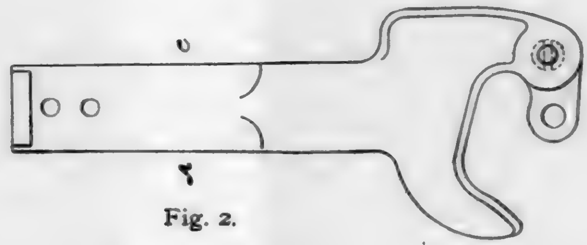


Fig. 3. Fig. 2.

Fig. 4.

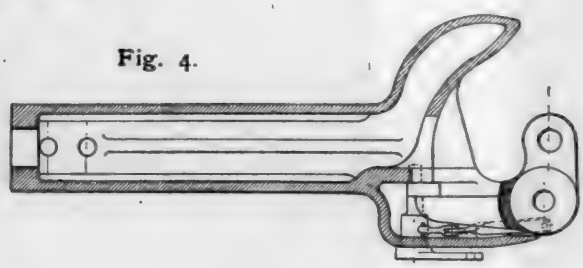
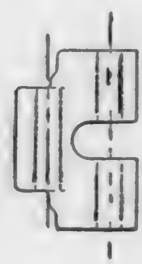


Fig. 6.



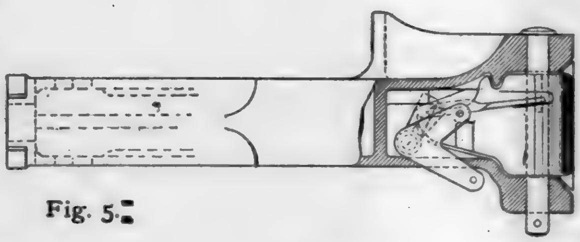


Fig. 5.

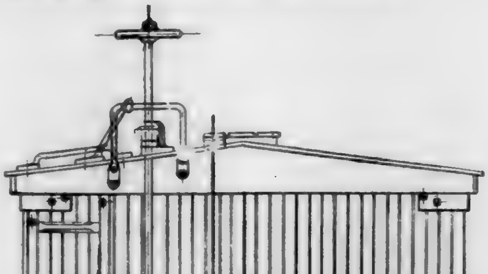


Fig. 7.

Fig. 8.

THE EMPIRE CAR COUPLER.

this work, agreed to begin on March 1, which was Tuesday. They encountered some delays and did not get to work until the Friday following, March 4. Saxton & Company, who have the contract for cabling the Blue Line, have opened an office in Baltimore and will soon start in on the north branch of this road, from the corner of Baltimore and Calvert streets to St. Paul Street and Huntingdon Avenue.

THE Baltimore & Ohio Company has placed an order with the Jackson & Sharp Company, Wilmington, Del., for 24 passenger cars for their Staten Island Division, to be delivered July 1.

THE Carlisle Manufacturing Company, Carlisle, Pa., is building 100 coal cars for the West Fairmont Coal & Coke Company.

THE Peninsular Car Company, Detroit, Mich., is building 200 double-hopper gondola cars for the Montana Coal & Coke Company.

THE little sketch given herewith is from the architect's design for the proposed passenger station of the Belt Railroad in

BELT RAILROAD STATION IN BALTIMORE.

Baltimore. It shows a building of brick, with stone trimmings, and the design, the leading features of which are well shown, is a very symmetrical and pleasing one.

THE Montague & Lea Machine Tool Company has been incorporated under the laws of West Virginia, with an authorized capital of $100,000. The incorporators are William L. Montague, Jr., Edward S. Lea and T. A. Dukehart, of Baltimore; Major H. W. Hunter and J. G. Coole, of West Virginia. The company will erect extensive shops and foundry at Moundsville, W. Va., 11 miles from Wheeling.

THE new tin-plate mill of Coates & Company, which has been under construction for several months past, and which has been given a number of preliminary trials, has been opened in earnest. The tin used in the past weeks was a portion of the first tin discovered in America. It came from California, and is regarded by some as being superior to the Welsh tin. Dr. L. R. Coates is the senior member of the firm and Mr. John Davis, a Welshman, is the Superintendent of the mechanical part of the enterprise, and they now have in hand large orders from Chicago, Boston and New York.

THE Baltimore & Ohio has given orders for the construction of 20 standard four-wheel caboose cars. The cars will be built at the Mt. Clare shops.

THE Sparrow's Point Steel Works have been awarded the contract for building a new steel clipper ship for one of the largest exporting firms in Boston, Mass., to be used in the trade with China. Captain Charles H. Nelson represents the Boston firm, and has much pleasure in the idea of giving to Boston her first steel bark. The vessel is to be a handsome clipper bark 220 ft. long, 39 ft. extreme beam, 24 ft. depth of hold, and of a tonnage of 1,500 net. Her hull, lower masts and topmasts, lower and topsail yards and bowsprit and jib-boom are to be of steel. She will have a full poop with wheel house way aft, and a charthouse just abaft the mizzenmast. Forward on the spar-deck there will be a commodious house containing the galley and stores and quarters for the crew. Quarters to accommodate four boys are also provided here entirely separate from the crew—a provision which Captain Nelson believes will encourage American parents to send their boys to sea. She will be equipped with large engines for sail and windlass, and have a magnificently fitted cabin that will permit carrying a number of first-class passengers if necessary. Work will be begun at once.

THE Baltimore & Ohio Company will have its Grafton & Greenbrier Branch widened and ready for the West Virginia Central & Pittsburgh trains to run over it on about May 20. The West Virginia Central has its line all in order from Elkins to Bealington. The company has been assured by the Baltimore & Ohio that the Morgantown Branch to Uniontown will be ready in October. When these lines are completed the West Virginia Central will be in splendid shape for shipping its freight to the West and Northwest, and by its connection with the Pennsylvania System will have the option of using the roads of the two big systems to put its coal and coke upon the lakes.

THE Baltimore & Ohio Railroad Company will have its State Line Railroad finished very soon. This new line is being rapidly completed, and Smithfield, which lies 9 miles from Uniontown, will have communication by June 1. The entire line will be finished by next spring, which will open up the rich and fertile country along the Cheat River to Morgantown; it will connect with the road already in operation between that point and Fairmont, where it meets the Main Line of the Baltimore & Ohio. The present distance from Pittsburgh to Cumberland is 150 miles, but by the building of the State Line route it is only 126 miles as surveyed. The engineer does not think that passenger traffic will decrease on the picturesque Baltimore & Ohio in Winter, but when the new road is in full operation, summer excursionists will prefer it to the old one on account of the vast number of camping clubs which visit the banks of the Cheat River. Several hundred go up there every summer. As a freight thoroughfare the State Line will be preferable on account of the difference in distance to Cumberland, while it will give the Baltimore & Ohio double facilities to expedite matters in that direction.

The Norton Compound Jack.

THE cuts herewith show a new form of jack, which combines the use of the lever and screw, and has several points of excel-

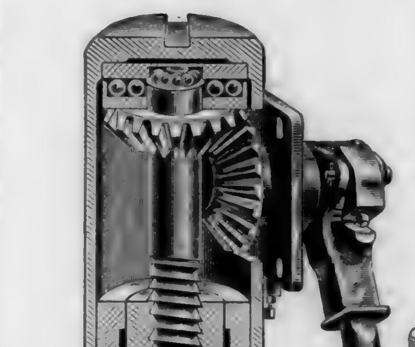


Fig. 1.

Fig. 2.

Fig. 3.

NORTON COMPOUND JACK.

lence for use on railroads and elsewhere. Fig. 1 is a sectional view; fig. 2 shows a jack with additional lifting hook; fig. 3 shows a jack made especially for the use of car inspectors. Figs. 2 and 3 are on a smaller scale than fig. 1.

These jacks are screw-jacks operated with a ratchet lever having the up-and-down or pump-handle motion, which is found very convenient in the hydraulic jack. They have a patent

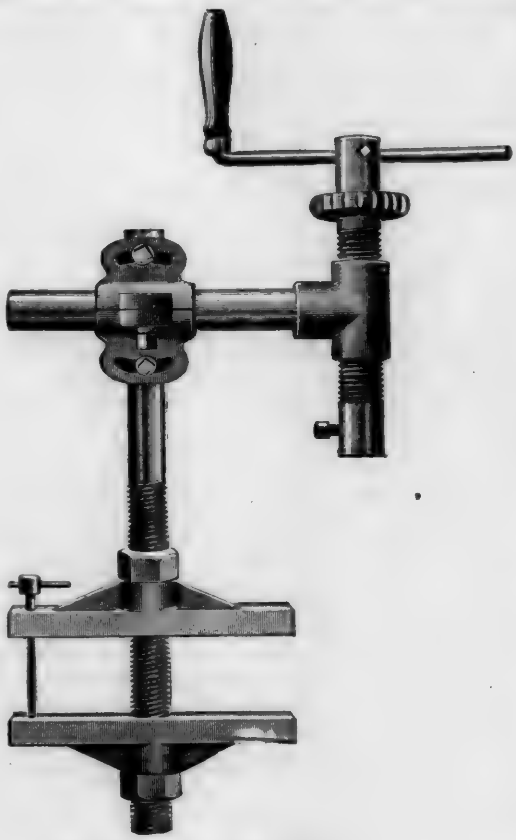
safety stop motion, preventing injury to jack or load by running the screw out of the nut. They are provided with a ball bearing, shown in fig. 1, which reduces the friction very much and prevents seizing, cutting and grinding. The screw is completely covered in, thus preventing corrosion, to which the screw of an ordinary jack is peculiarly subject, as those who have occasion to use such an appliance know very well.

The lifting hook shown in fig. 2 is a very convenient attachment; with it the jack can take hold of a load close to the ground, in cases where it would often be necessary without it to dig a hole for the jack to stand in. The use of the car inspector's jack, shown in fig. 3, will be readily understood.

Some of the advantages of this device are noted above; the claims made for it may be shortly summed up by saying that it is simple, durable and cheap, and can be applied for almost every purpose. These jacks are made by Mr. A. O. Norton, of Boston, and have met thus far with much approval.

A Useful Small Tool.

The illustration herewith shows a clamp-drill, a tool which will be found useful in almost every machine shop, especially



BURNHAM'S CLAMP DRILL.

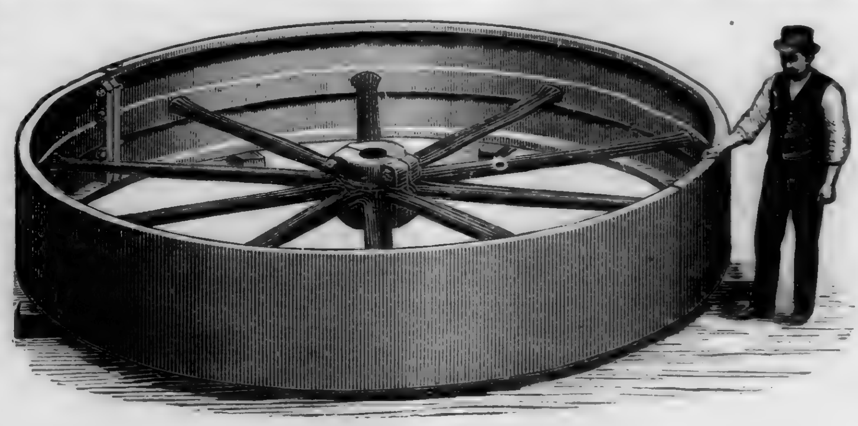
in repair shops. The one shown seems to be a well-made tool, and as light as it can be made, consistent with proper strength. Its construction will be readily seen from the engraving. It has one advantage over others of the same kind, in the arrangement of the slots and set-screws at *a a*, by which the operator can square his drill with the work regardless of the position of the clamps. The drill has the usual feed arrangement.

This tool is made by the firm of George Burnham & Company, Worcester, Mass.; it is made in several sizes, the largest being able to drill a 1-in. hole 4 in. deep. The posts are of steel, the clamps of cast steel and the swivel motion malleable iron.

The drill shown in the engraving is one of the smaller size, drilling only up to a $\frac{3}{8}$-in. hole. The larger sizes are provided with gearing to increase the speed, as in the ordinary drill.

A Large Pulley.

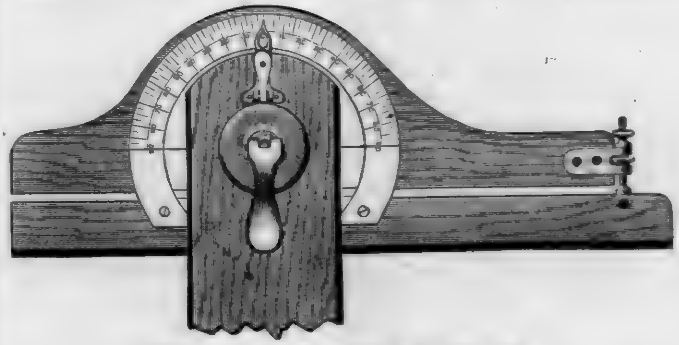
The cut given herewith shows a pulley recently cast and finished at the foundry of L. H. Goodnow in Fitchburg, Mass. The man in the engraving is introduced to give some idea of the comparative size. This pulley is 18 ft. in diameter and 48 in. face; it was cast in two halves, and weighs 18 tons. Pulleys up to 20 ft. diameter have been made in the establishment named.



A LARGE PULLEY.

An Adjustable T-square.

Almost every draftsman will at once appreciate the advantages of a T-square which can be quickly and certainly adjusted



DEANE'S ADJUSTABLE T-SQUARE.

to any required angle, and which contains within itself the means of ascertaining that angle. Such a device is shown in the accompanying illustration; it is the invention of Mr. E. L. Deane, of Holyoke, Mass.

The head has, as will be seen, an inner bar, which bears against the edge of the drawing-board, and an outer bar or head, to which the blade is attached. A protractor is fastened on the inner bar, and a pointer on the outer bar indicates the angle at which the blade is set. The two bars are connected by a pivot at the center of the protractor; this is not shown in the engraving, being covered up by the hand-lever, which has a cam at the end serving to clamp the outer head in place and prevent it from moving. It is released by simply raising this small hand-lever. A further connection is made by the screw and thumb-nut at the end of the long arm of the outer bar, which serves to adjust the relative positions of the two bars. Another thumb-nut and screw on the under side of the central pivot serves to adjust the connection, so that the locking cam will have the proper bearing.

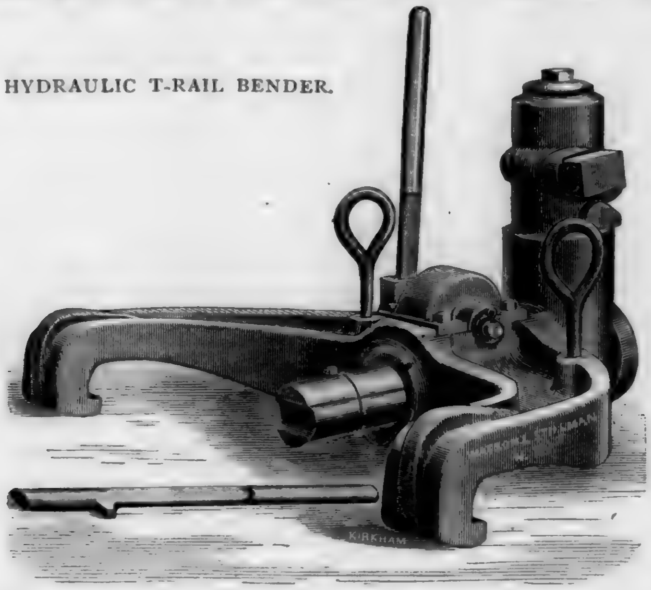
The use of the protractor and the arrangement of the parts will be readily understood from the engraving. It will be seen that the device is really a simple one, and that the blade can be readily given the smallest or a greater adjustment, and provision can be made for the differences in a board which is not exactly square—often a great convenience.

The Hydraulic Rail Bender.

The various forms of screw rail-benders have not altogether given satisfaction with heavy rails, and they also require a considerable gang of men to handle them. The accompanying engraving shows a hydraulic rail-bender which will, it is claimed, obviate the objections made to the screw benders. Careful experiments have shown that it was not the method of bending, but the long spacing which sprung the rail up, so that a very heavy hook to catch the web was not necessary. In this

tool the ram may be run in and out without pumping for a distance of $3\frac{1}{2}$ in. This allows the tool to be placed over the rail and the ram brought up to its work on the rail-head, when a few strokes will bend the rail to the desired curvature; it may then be slid along easily and another pressure given. The ram is graduated to show the spring of rail, and has a loose steel head which fits the rail-head which is being bent. In a

HYDRAULIC T-RAIL BENDER.



recent test in service two men bent 40 steel rails 30 ft. long, 90 lbs. to the yard, in one day, where previously 20 had been the best work of six men with best of screw benders, and one rail was bent perfectly flat on 45 ft. radius in $1\frac{1}{2}$ minutes, on 16 in. centers of application.

This tool can be worked by one operator. The No. 4 size, shown in the engraving, weighs 275 lbs. They are made by the well-known firm of Watson & Stillman, of New York, and have just been placed on the market.

PERSONALS.

C. F. KOHLMAN has been appointed City Engineer of Racine, Wis.

J. A. MCNICOL has been appointed Engineer and Manager of the Hamilton Bridge Company at Hamilton, Ont.

CHARLES FRANCIS has been appointed Chairman and Supervising Engineer of the Board of Public Works of Davenport, Ia.

GEORGE B. CORNELL, recently Engineer of the Cornell Iron Works in New York, has been appointed Chief Engineer of the East River Bridge Company.

S. M. RODGERS, for some time past with the Pittsburgh & Western Railroad, is now Chemist of the Harnesworth Steel Company, in Pittsburgh, Pa.

S. HIGGINS has been appointed Assistant Superintendent of Motive Power of the New York, Lake Erie & Western in place of W. F. Turreff, deceased.

PROFESSOR HENRY C. ADAMS, Statistician of the Inter-State Commerce Commission, has been appointed Lecturer on Finance in the Johns Hopkins University in Baltimore.

JAMES E. SAGUE has been appointed Assistant Superintendent of the Schenectady Locomotive Works. He has been for some time Mechanical Superintendent of the railroads in Jamaica, in the West Indies.

GEORGE S. MORISON, C.E., has removed his Chicago office from The Rookery to Room 800, The Temple, corner of La Salle and Monroe streets. His New York office remains at 35 Wall Street as heretofore.

H. DE B. PARSONS is giving a course of lectures on the Steam Engine at the Rensselaer Polytechnic Institute. The course will last three months, two lectures a week being delivered.

GENERAL GEORGE S. FIELD has withdrawn from the Union Bridge Company, and purposes giving his entire time to his duties as Chairman of the Board of Public Works of the city of Buffalo.

C. A. THOMPSON has been appointed Superintendent of Motive Power of the Central Railroad of New Jersey. He was for a number of years in the same position on the Long Island Railroad.

EPES RANDOLPH has been appointed Chief Engineer of the Newport News & Mississippi Valley Company's Western Division. C. T. SABIN is now Engineer of Bridges and Buildings of the same division.

GENERAL V. E. MCBEE, for some time past General Superintendent of the Central Railroad of Georgia, has resigned that position, and it is said he has been offered an important position on the Lake Shore road.

THOMAS ALDCORN has resigned his position as Division Master Mechanic of the West Shore Railroad to accept the position of Mechanical Superintendent of the Empire Car Coupler Company, with office at 15 Warren Street, New York.

PROFESSOR MANSFIELD MERRIMAN, now of the Lehigh University at Bethlehem, Pa., has been offered the position of Professor of Mathematics in the Chicago University. Professor Merriman is well known as an author and as a high authority in his department.

COLONEL WILLIAM G. RICE, Vice-President of the Consolidated Car Heating Company, has just returned to Albany from a short trip abroad. During this trip he has carefully studied English railroad methods, and some of his impressions have been published in an interesting interview in the Albany *Argus*.

A. E. MITCHELL has been appointed Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, with office in New York, succeeding the late Ross Kells. Mr. Mitchell has been Mechanical Engineer of the road for some time. He is also appointed to the same position on the Chicago & Erie Railroad.

WALTER KATTÉ, GEORGE BIRDSALL, J. B. HASKIN, C. W. DAYTON and JOHN FOX compose the commission in charge of the raising of the bridges over the Harlem River and the tracks leading thereto. Mr. Birdsall is Chief Engineer of the Department of Public Works of New York, and Colonel Katté is Chief Engineer of the New York Central & Hudson River Railroad.

THEODORE N. ELY, for a number of years General Superintendent of Motive Power of the Pennsylvania Railroad, has been promoted to be Fourth Vice-President of the Company, with office in Philadelphia. His successor as General Superintendent of Motive Power is F. D. CASANAVE, who has for some time held the same position for the Pennsylvania Company at Fort Wayne.

JOHN A. GRANT has resigned his position as Vice-President and General Manager of the Texas & Pacific Railroad. Captain Grant has served as Chief Engineer of the Port Royal & Augusta and of the Northeastern of Georgia; as Superintendent of the Macon & Brunswick; as Chief Engineer and Superintendent of the Newport News & Mississippi Valley, of the Memphis & Charleston and of the Louisville, New Orleans & Texas, and has been on the Texas & Pacific for several years past.

OBITUARIES.

ERASTUS O. HILL, for many years connected with the New York, Lake Erie & Western Railroad—last as Superintendent of the Eastern Division—died April 29 at Matamoros, Pa., where he had resided for some years.

CLARK JOHNSTON, who died in Rochester, N. Y., April 25, aged 69 years, was well known as an engineer and a railroad contractor. He built several sections of the Wabash Railroad, and held large contracts on other Western lines.

O. L. SPENCER, who died in Joliet, Ill., April 27, had many years' experience as a rolling-mill manager and was well known among iron men. He had been for some time Superintendent of the mill at Joliet, where he introduced a number of improvements in the plant.

SIR JAMES JOSEPH ALLPORT, who died recently at the age of 81 years, was one of the best known and most progressive of English railroad men. He had been a director of the Midland Railway for nearly 30 years, and General Manager of that line for a number of years past; recently he was made Chairman of the Board.

THEODORE L. WOODRUFF was killed by a train while crossing the West Jersey tracks at Gloucester, N. J., on May 2; he was 81 years old. Mr. Woodruff built one of the earliest sleeping cars, which was put in use on the St. Louis, Alton & Terre Haute Railroad about 1857, and very soon afterward he took out a patent on his car. The Woodruff sleepers have been used on various roads, but never reached the success attained by the Pullman and Wagner cars, chiefly on account of lack of capital and business method.

WILLIAM P. SHINN, who died in Pittsburgh, May 2, aged 57 years, was born in Burlington, N. J., and began work as a civil engineer at an early age. After some time spent as an assistant in county surveys in New England, he entered the service of the old Ohio & Pennsylvania—afterward the Pittsburgh, Fort Wayne & Chicago—Railroad as a rodman. He was rapidly promoted to be Assistant Engineer in charge of a division, and some 80 miles of the road were located and built under his supervision. In 1855 he was transferred to the traffic department, and for a number of years held responsible positions in charge of freight and passenger traffic. When the Pennsylvania Company was organized, Mr. Shinn was appointed as an expert to examine the affairs and conditions of the various companies interested in the leases to that Company. From May, 1871, to May, 1873, he had charge of the construction of the Ashtabula, Youngstown & Pittsburgh Railroad, and in 1873 he became President of that road. In 1874 he was Vice-President of the Allegheny Valley Company, and did some notable work in connection with the tangled accounts of that company.

From January, 1873, to October, 1879, Mr. Shinn was the managing partner of Carnegie, McCandless & Company, and had charge of the building and operating of the Edgar Thomson Steel Works. In 1879-80 he reorganized the Vulcan Steel Company, of St. Louis, and rebuilt and started those works. From 1881 to 1887 he was Vice-President of the New York Steam Company, for the distribution of heat by steam through the streets of New York. From December, 1886, to December, 1889, he was Vice-President in responsible charge of the New York & New England Railroad, and in 1888-89 he was President of the Norwich & New York Transportation Company.

Mr. Shinn was elected a member of the American Society of Civil Engineers September 15, 1869, and January 15, 1890, he was made its President. In 1875 he was elected a member of the Institute of Mining Engineers. In 1876 and 1877 he was one of its Vice-Presidents, and in 1880 he was elected President. He was an active member of both societies and contributed some valuable papers to their *Transactions*.

Mr. Shinn's last days were clouded by ill health and by the loss of his wife, to whom he was very tenderly attached, and his death was not unexpected.

Perhaps his strongest characteristic was thoroughness. Always a hard worker, he devoted himself to the task at hand, and spared no trouble or pains to complete it. He was a close and careful student of traffic problems during his railroad service, and few men understood them better than he did. Very few, also, would work as he did, on the Allegheny Valley and afterward on the New York & New England, under most discouraging conditions, intent only on doing his best, no matter what the result to himself. Such men are rare, and the places they leave are not easily filled.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, April 20, there was a discussion on the preliminary report of the Committee on Uniform Methods of Tests. Mr. H. B. Seaman, one of the Committee, made a brief statement of the purposes of the report, and the discussion was continued by Messrs. Morison, Buck, Henning, Bush and others.

AT the regular meeting in New York, May 4, the Secretary announced that the Board of Directors had voted to take charge of the departmen of Civil Engineering at the Congress of Engineers to be held during the Columbian Exposition.

The first paper of the evening was a discussion presented by C. C. Babb, and read, in his absence, by the Secretary, on the Hydrography of the Potomac Basin. A second paper was read by A. H. Dunham, on a New Method of Tunnel Alignment. Mr. Dunham used a fixed transit station outside the portal of the tunnel, and a fixed back-sight, sighting into the tunnel at a plummet lamp suspended from a bracket held against one of the wall plates. There was a short discussion on this paper.

The chair announced the election of the following *Members:* Charles Francis, Michael L. Lynch, Otto von Geldern and M. E. Yeatman. *Associate Members:* W. A. Aycrigg, R. A. Cummings, Frans Engström, Janon Fisher, Louis Focht, A. S. Going, J. E. Hill, J. J. L. Houston, J. M. Porter, Joseph Strachan, W. L. Webb, H. R. Wheeler. *Associates:* Clarence B. Marriot, L. B. Bonnett, Oscar Lowinson, W. B. Martin, L. G. Montony, W. H. Polk, Julius Price, W. B. Yeareance.

American Institute of Mining Engineers.—The sixty-second meeting of the Institute will be held in the Lake Champlain region, beginning at Plattsburgh, N. Y., Tuesday evening, June 21. Arrangements are in progress for visits to mines and furnaces, and a trip into the Adirondacks. Contributions to the discussion of magnetic iron-ore concentrations and also of crushers, granulators and pulverizers are especially invited.

A special circular has been issued to members and associates upon the Columbian Exposition fund for an engineering headquarters. The Council desires to contribute for the Institute $4,000 toward the international headquarters, and subscriptions are asked, the sum of $5 being suggested as a minimum subscription.

American Society of Mechanical Engineers.—The following papers were presented at the San Francisco meeting:

C. H. Peabody, Economy and Efficiency of the Steam Engine; B. J. Dashiell, The Electric Railroad as Applied to Steam Roads; A. F. Nagle, The Density of Water at Different Temperatures; William O. Webber, Some Tests of a Portable Boiler; William S. Aldrich, Compounding Centrifugal and Load Governing by a Rotary Piston Valve; John Richards, Notes on a Problem in Water Power; W. F. M. Goss, An Experimental Locomotive; A. W. Stahl, Utilization of Power of Ocean Waves; John H. Cooper, A Self-Lubricating Fiber Graphite for the Bearings of Machinery; Thomas Gray, Autographic Recording Apparatus for Use in Testing Materials; Thomas Gray, The Measurement of Power; Harris Tabor, Machine Molding; F. M. Rites, The Steam Distribution in a Form of Single-Acting Compound Engine; Gus. C. Henning, On the Elastic Curve and Treatment of Steel; C. H. Manning, A Novel Fly Wheel; W. R. Eckart, Friction or Lost Work of Cable Railroads; W. W. Christie, An Experiment with Aluminum; Denton and Jacobus, Summary of Results of Principal Experimental Measurements of Performance of Refrigerating Machines; Green and Rockwood, Two Cylinders *vs.* Multicylinder Engines.

THE annual meeting began in San Francisco, May 16, the opening session being held on the evening of that day. The visiting party from the East, including about 40 members accompanied by a number of ladies, arrived in the morning, and in the afternoon were escorted to several points of interest, including the great cable railroad plants of the city. The reception was in charge of the California Academy of Sciences and the Technical Society of the Pacific Coast.

At the meeting in the evening an address of welcome was made by Mr. John Richards, President of the Technical Society of the Pacific Coast, and an appropriate response was made by Mr. Robert W. Hunt, President of the American Society. The meetings and excursions were carried out according to the programme already published. A large number of papers were presented and discussed, a list of the principal ones being given above.

A number of topical subjects were also suggested and discussed.

This was the first meeting of the Society on the Pacific Coast, and although the attendance was necessarily limited by the distance and expense, it must be considered a very successful Convention, and was thoroughly enjoyed by those who were able to attend.

American Water-Works Association.—The Twelfth Annual Convention began in New York, May 18, with a large number of delegates present. The opening address was delivered by the President, J. M. Diven, of Elmira, N. Y. The reports of the officers were presented, showing the Association to be in excellent condition, and with an increasing roll of members.

The afternoon session was devoted to reading and discussion of papers. Those presented were the Brooklyn Water Works, by Samuel McElroy; Plumbing Work, by L. E. Gray; New Water Supply for Atlanta, Ga., by W. S. Richards; Restrictions on Franchises to Private Water Companies, by J. Nelson Tubbe.

In the evening a public reception was given to the delegates

by a number of city officers and prominent citizens at the Metropolitan Hotel.

On the second day two sessions were held, at which a number of papers were read and discussed. In the evening the delegates visited the theater in a body.

On the third day, Thursday, a morning session was held, at which several papers were presented and a number of questions suggested and discussed. In the afternoon a business meeting was held, at which it was decided to hold the next convention in Milwaukee, Wis., and the following officers were elected: President, G. H. Bonzenberg, Milwaukee. Vice-Presidents, James P. Donahue, Davenport, Ia.; R. C. P. Coggeshall, New Bedford, Mass.; R. M. Clayton, Atlanta, Ga.; S. E. Babcock, Little Falls, N. Y.; W. H. Watts, El Paso, Tex. Secretary and Treasurer, Peter Milne, Brooklyn, N. Y. Finance Committee, William Ryle, Paterson, N. J.; William Molis, Muscatine, Ia.; W. G. Richards, Atlanta, Ga.

Friday was devoted to visiting the Brooklyn Water Works and some other points of interest, and on Saturday the Convention closed with a steamboat excursion, members being taken to the Navy Yard and other points around the harbor.

New England Water-Works Association.—The eleventh annual convention will be held at Holyoke, Mass., beginning June 8 and lasting three days. An interesting programme has been prepared by the Committee of Arrangements, and a large attendance is expected.

American Society of Irrigation Engineers.—Mr. Arthur D. Foote, President, has issued the following circular:

"At the close of the Irrigation Congress in Salt Lake City, on September 18, 1891, a few engineers who were delegates were called together by Professor L. G. Carpenter, of Colorado, who suggested the organization of a Society of Irrigation Engineers.

"A meeting was held during the evening at the rooms of the Polytechnic Society of Utah. Little time or opportunity was afforded for details of organization. Officers were, however, elected, and the Board of Directors was instructed to draft a constitution and by-laws and send it to the members for suggestions and additions. A few hours of rather informal discussion brought out the ideas of those present as to the aims and work of such a society.

"It seemed evident to all that an organization of men interested in the physical problems of the arid regions would be of benefit to its members, and also that an organized body of skilled engineers with experience in the peculiar work of Arid Land Reclamation was almost a necessity, not for the increase of their own knowledge only, but far more for the security of those investing their time and money in reclamation or irrigation works.

"After adjournment the party dispersed, returning to their home or work in every State or Territory in the arid country, with little in the shape of a society except the hope that something useful would grow out of the meeting.

"The members of the Board of Directors reside in California, Colorado, Utah, and Idaho, and, being engineers, have many duties and little time for traveling, so that it was February before a meeting was arranged.

"In the mean time the Secretary had received many letters and much encouragement from irrigation engineers, and when the Board met it was found that 200 members were assured for the Society, including several from Europe, India, Egypt, Mexico, and South America. Success seemed no longer in doubt not only for an American society, but one that would extend all over the world.

"The Board of Directors spent several days in drawing up a Constitution and By-Laws adapted to a society, the members of which will necessarily be widely scattered. The members of the Society will be able to judge of the result of their labors as soon as the Secretary can send them the printed copies.

"The Constitution of the Society admits of

"*Members:* Those who are professional irrigation engineers.

"*Associates:* Those who, by their knowledge and experience, can co-operate with engineers in the work of irrigation.

"*Juniors:* Young men who intend to become irrigation engineers.

"There will be one annual meeting of the Society, and it is hoped that there can also be one meeting each year in San Francisco, Denver, Salt Lake, and possibly in other cities north or south. At these meetings papers will be read and discussed in the usual manner.

"It is the intention to have every one in the Society, at least once a year, give in writing something of his experience or something of his knowledge which will be of benefit. These will be published annually in book form, and this gathered experience and knowledge of irrigation engineers and of men building and managing irrigation works should be of great value and interest not only to members of the Society, but also to that vast public who are interested in the great problems of Irrigation, Forestry, and cognate subjects."

New England Railroad Club.—At the regular meeting in Boston, May 11, Colonel Frank H. Forbes gave some interesting reminiscences of the early days of railroading in New England.

The Club then took up the discussion of the Rules of Interchange. Several amendments were presented and advocated.

Central Railroad Club.—At a meeting, held in Buffalo, April 27, the Committee appointed at a previous meeting reported several amendments to the Rules of Interchange, which were discussed at some length, and approved, after some slight changes had been made.

There was also some discussion on a proposed new form of pass card to be used only for cars in local business; it is to be applied in addition to the regular defect card, when a car is in need of repairs.

New York Railroad Club.—At the regular meeting, April 21, there was no subject assigned for discussion, but the members were requested to introduce topics.

Mr. Dale spoke of a new coupler, which, it is believed, has sufficient strength to obviate the objection of breaking knuckles, which is brought against the M. C. B. coupler.

The subject of removing defect cards was brought up by Mr. West and discussed by him and by Messrs. Adams, Smith and others.

The President suggested the subject of leaking locomotive tubes, on which there was a long discussion, a number of members giving their experience, as to the effect on tubes of different kinds of coal, of dead-plates, brick arches and other devices.

Mr. Adams brought up the subject of roller bearings, and stated that on his road they had been trying the Meneely bearing and also a ball bearing, both with considerable success. The subject was further discussed by Messrs. Rogers, Brady, Blackall and others.

AT the regular meeting in New York, May 19, Mr. D. L. Barnes read a paper on Draft Rigging for Freight Cars, which was illustrated with a number of diagrams. A discussion followed.

Western Railway Club.—At the regular meeting in Chicago, April 19, the time was devoted to a general discussion of proposed amendments to the Rules of Interchange. A number were suggested and advocated by different members.

AT the regular meeting, May 17, Mr. W. H. Lewis presented a paper giving the results of experiments with Exhaust pipes and Nozzles of different sizes.

Mr. E. N. Herr read a paper on Irregular Wear of Locomotive Driving-wheel Tires, giving a number of instances drawn from experience.

Franklin Institute.—At the regular meeting in Philadelphia, April 20, the Secretary reported the death of Mr. William A. Cheyney, Auditor of the Institute, and a committee was appointed to prepare a suitable memorial of the deceased.

Mr. E. H. Outerbridge, of New York, gave a description of a new article of manufacture, called "Pantasote" leather, designed principally to serve as a substitute for leather, and especially for the more costly varieties of leather employed for upholstery, wall decorations, traveling bags, etc.

Mr. Thomas P. Conard presented a description, with lantern projections, of the Shay Geared Locomotive.

Mr. T. F. Cook, of Tacoma, Wash., followed with a description of a new method of transportation recently invented by him. The inventor employs an overhead system, the permanent way consisting of a single line of columns carrying an upper and lower girder. The invention consists further in an arrangement of horizontal pulleys, which are carried on the lower girder, adapted to be driven by any suitable motive-power and by which motion is communicated to the cars. The latter are arranged to travel in opposite directions on the two sides of the elevated structure.

THE Committee on Science and the Arts, at its stated meeting of May 2, adopted reports on the following subjects: Millikin's improved post for electric service; Gibbon's street railroad rail; Golding's & Durkee's expanded metal; Lungren's

incandescent gas-burner; McClellan's anti-siphon trap-vent; the Woodbury engine, and Roeder's & Greene's improved windows. In the cases of Gibbon, Golding & Durkee, Lungren and McClellan, the Committee recommended the award of the John Scott Legacy Premium and Medal, and in the case of Roeder, the applicant was awarded the Edward Longstreth medal.

Engineers' Club of Philadelphia.—The regular meeting of April 2 was devoted to an informal discussion of the trolley system for operating street cars by electricity. A large number of members took part in the discussion, and the arguments for and against this system were strongly stated. The discussion was not concluded, but was continued to the meeting of May 7.

Engineers' Society of Western Pennsylvania.—At the meeting of the Chemical Section, March 24, Mr. James O. Handy read a paper on a rapid method for Phosphorus Determination in Iron, Steel and Ores.

At the regular monthly meeting of the Society, April 19, Professor J. W. Langley, for the Committee on Smoke, reported that the Committee had met and assigned each detail to be considered to different members of the Committee.

The paper of the evening was read by Mr. G. S. Davison, on Discharge Observations of Large Streams. The paper reviewed in brief the work accomplished by separate investigations, beginning in the seventeenth century and closing to date. It was especially interesting in the details furnished from the author's personal work, when engaged as an Assistant Engineer under the Mississippi River Commission during 1879 and 1880, when he was detailed for duty at Fulton, Tenn., about two miles below the historic Fort Pillow. A full description of the character and management of the floats, both single and double, was given in detail, as well as the method of obtaining mid-depth velocity. The irregularity of all results obtained from different known formulas was shown. The paper concluded with the following *résumé*:

"As to the particular system to be used, we believe the double-float system, carefully conducted, will give good results up to a velocity of 10 ft. per second. Current meters, carefully rated for coefficients and used with chronograph, will give very accurate results. They are stationary at a point in the section while in use. The former depends on the average of its approach to and departure from the discharge section for its main velocity through the same, while the latter gives the condition of things immediately at the section. The meter cannot be used for high velocities, as in swift currents it would be difficult to hold in place the craft from which the observation must be taken. In the experiments at Burlington, Ia., comparisons of these systems were made, showing very slight differences, so slight as to practically give the same results. The current meters recorded the actual pulsations of the water, thus representing very slight change in the velocity. All the oscillations within the path of a moving float are averaged."

The paper was illustrated by cuts showing cross-sections of the river, the floats, and the lines of observations.

Engineers' Club of Cincinnati.—At the April meeting of the Club there was an attendance of 45 members and several visitors. One new member was elected and three applications for membership presented. There has been a very active interest in the affairs and administration of the Club during several months past.

Mr. Bouscaren read a very interesting paper on the subject of the work being done to restore the anchorage of the cables of the suspension bridge between Cincinnati and Covington. The bridge was erected in 1866, and a recent examination of the anchorages revealed the necessity of strengthening the cables at these points, and Mr. Bouscaren has had charge of the work.

At the last regular meeting of the Club 13 new members were elected, making the membership 123 at that date.

Colonel Latham Anderson read a paper on a proposed New Type of Dam. He was a member of a commission of Engineers appointed by the Arrowhead Reservoir Company, to prepare plans for a system of irrigation for supplying the territory north and west of San Bernardino, Cal. The water for this purpose is to be obtained from the headwaters of the Majore River. In a particular basin in the mountains at this place, described by the writer, there are four consecutive branches of the Majore having admirable sites for dams and reservoirs, all of which will be used, but the largest and the one which will be used first is known as the Little Bear Valley.

Engineers' Club of St. Louis.—At the regular meeting, April 20, Captain C. F. Palfrey was elected a member.

Mr. B. F. Crow then read the paper of the evening on Elements Involved in Rapid Transit. The subject was divided into two parts: First, the development of a new system, and second, the study of methods to increase the efficiency of lines already in existence. The second method is the one in which the greater number are interested. One of the greatest drawbacks to rapid transit has been the poor roadbeds and poorly designed curves which answered the purpose for the horse cars, but were inadequate for the present system. The terminal facilities was another point which made trouble when it was attempted to run a number of trains with a small headway. The question of stops was one which presented serious difficulty to obtaining any high rate of speed. The paper also dwelt on the question of car construction, and showed some of the advantages obtained by newer and better designs.

Discussion followed by Messrs. Hermann, Crow, Seddon, Moore, Johnson, Crosby, Olshausen, Maxon, Colby, Russel and Woods.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held May 16, in the Club rooms. Five active and one associate member were elected. Dr. Staley, President of Case School of Applied Science, was elected delegate to the Fifth International Congress on Inland Navigation.

Mr. C. W. Hopkinson read an interesting paper on Whither is our Architecture Tending?

Mr. Searles, a member of the Club and one of the engineers of the North River Bridge at New York, gave a very interesting account of the proposed structure.

Denver Society of Civil Engineers.—At the regular meeting April 27, Mr. Thomas Withers read a paper on the Ventilation of Tunnels, describing the various methods which have been tried.

Mr. F. H. Whiting read a paper on Electric and Cable Railroads in Denver. Both papers were briefly discussed by members present.

Technical Society of the Pacific Coast.—At the April meeting in San Francisco, Andrew Fraser, Edward C. Jones, Leon H. Taylor and Professor Charles David Marx were elected members.

Mr. D. E. Hughes presented a paper on the Sickle, or Perfect Railroad Curve.

The following question was submitted for discussion: "What is the effect of Modern Brakes upon the Railroad and its Supporting Structures?" The discussion was carried on by Messrs. Von Geldern, Hughes, Curtis and others.

Professor Willard D. Johnson made an address on the proposed Topographical Survey of the State, and a special committee was appointed to aid in advocating such a survey.

NOTES AND NEWS.

A Remarkable Hydraulic Plant.—The Pelton Water-Wheel Company, of San Francisco, is constructing a water-wheel 36 in. in diameter, to operate under a head of 2,100 ft., or a pressure of more than 900 lbs. per square inch. The wheel is to run at 1,150 revolutions per minute, and have a speed at its periphery of 10,805 ft. per minute, which is at least one-third faster than circular saws are driven. The wheel is to be placed in one of the Comstock mines and, in addition to the depth of the mine, is to be fed from the Virginia water-mains, which have a pressure of 198 lbs. to begin with. The diameter of the jet will be only 0.15 in. The wheel will be of solid steel, a tempered plate ⅜ in. thick.

It is a remarkable case, and will be watched with much interest. Various kinds of phenomena will, no doubt, be observed in respect to erosion of the surfaces, especially of the nozzles. This will be by far the greatest head or pressure ever applied to a water-wheel.—*Industry, San Francisco.*

Protection for Steel Ships.—The *Revue Scientifique* notes that at a recent meeting of the Institution of Naval Architects, in England, Mr. F. C. Goodall, Engineer for the Corporation of the Trinity House—which is the Board in charge of lighthouses—strongly recommends the use of steatite for coating the plates of steel ships. Steatite, more commonly known as soapstone, is a soft magnesian rock which is found in the Alps, in England, in Germany, in the United States and in China in large quantities. It has some valuable qualities. It is not affected by extreme temperatures nor atmospheric influences; it is incombustible; it is a very bad conductor of heat; it is not a conductor of electricity at all; it is not attacked by acids;

finally, it can be ground very fine and will adhere closely to a smooth surface.

It is stated that the Chinese, anticipating European invention here as in some other cases, have for many centuries used this mineral as the base of a paint used for covering stone buildings and for painting their junks.

Mr. Goodall states that when mixed with oil or with an ordinary dryer, steatite will not dry completely; but, aided by the advice of the Holzapfel firm, he has obtained excellent results by dissolving it in a varnish. The varnish makes a pigment sufficiently elastic to prevent cracking, while the pores are entirely filled by the very fine particles of the steatite, and a coating is formed which, it has been shown by experiment, will protect iron and steel plates from the air, water and galvanic action, through a period of several years. It is, moreover, not an expensive material, and can be readily obtained in large quantities and ground up to the required fineness without difficulty.

In this connection it is well also to recall the experiments in the use of lacquer for ship's plates, which is advocated by Mr. Hotta, and to which reference has heretofore been made in our columns. Some interesting experiments are now in progress in this direction with lacquer as a protection for iron and steel against the corroding influences of air and sea water.

A Gas-Fired Boiler.—The accompanying cut shows a form of gas-fired boiler lately patented in England by G. H. Taylor and W. O. A. Lowe. It is an improvement of that form in which the gases are led from the producer to the combustion-chamber by means of downtakes. In the new form these may

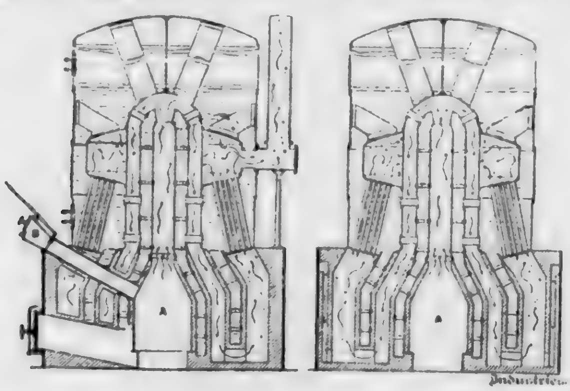
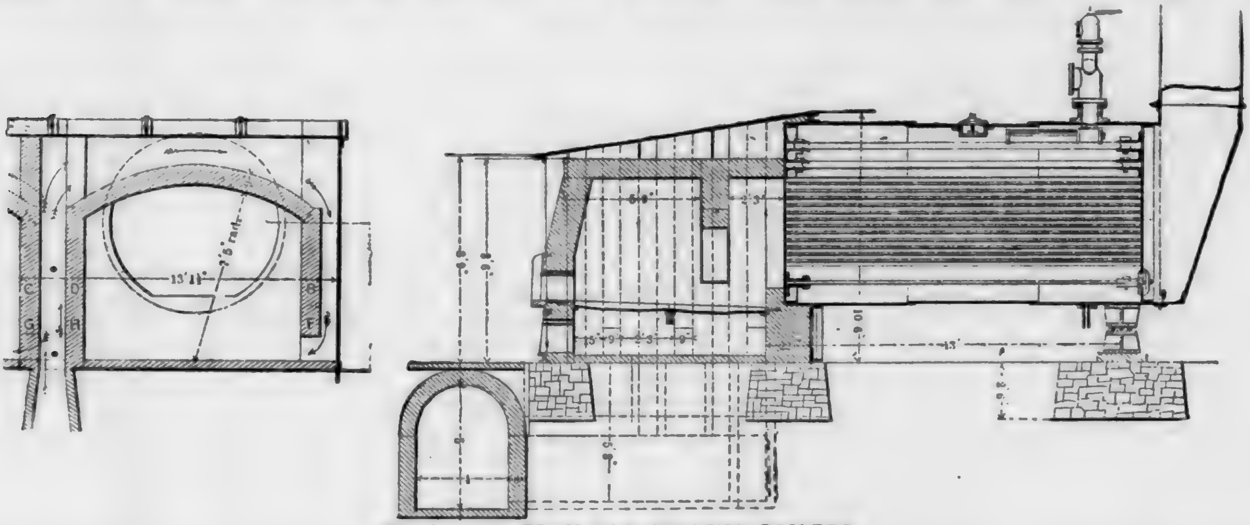


FIG. 1. FIG. 2.
A GAS-FIRED FURNACE.

be dispensed with, and the producer, along with the uptake, is surrounded by an enveloping hollow chamber, into the upper end of which the gases generated in the producer are led, and down which again they are conducted into the combustion-chamber, where ignition takes place. A water-space is left between this enveloping chamber and the producer and uptake, and this space is, by means of suitable passages or openings, placed in free communication with the surrounding water contained in the boiler, so as to ensure perfect circulation, as well as to permit of the escape of steam into the surrounding water in the boiler. The accompanying illustrations, figs. 1 and 2, represent vertical sections at right angles to each other of a boiler so constructed; the arrows shown in full lines representing the course of the gases, while those shown dotted represent the course of the air. *A* represents the producer furnace, and *B* the hopper through which fuel is supplied.

A Good Boiler Setting.—For some time past the Wellman Iron & Steel Company, of Thurlow, Pa., have had running in their No. 2 boiler house a battery of boilers designed by S. T. Wellman, which embody novel features, and, using a cheap



WELLMAN'S PLAN FOR SETTING BOILERS.

coal, have proven very economical. As will be noted from the accompanying engravings, the notable point in the design of the boiler is the fact that it has a detached fire-box, and that the products of combustion pass simply through the flues to the stack. The direct tubular boilers are each 90 in. diameter of shell and 15 ft. long, and contain 266 flues 2½ in. in diameter. The area of heating surface is 2,300 sq. ft., while the grate surface is 64 sq. ft., the area through the tubes being 7½ sq. ft. The ratio of the heating to grate surface is, therefore, 36 to 1, while the ratio of grate surface to tube area is 8½ to 1. The boilers use forced draft at 1 oz. pressure, supplied by a Sturtevant blower. As will be seen from the drawings, the air is forced through underground flues up through the side walls of the furnaces over the roof and front, being thus slightly heated. It then passes to the ash-pit and under the grates. One result of this method is that the front is kept quite cool. In February a number of tests were made on No. 4 boiler with average results as follows: Coal burned per hour per square foot grate, 12.9 lbs.; water evaporated per hour, per square foot heating surface, 2.9 lbs.; water evaporated per pound of coal, 8.03 lbs. The average boiler pressure was 93 lbs.; temperature of feed-water, 124.5°; temperature of escaping gases, 410°. The three tests, from which these averages are taken, lasted in all 254¾ hours; during that time fires were cleaned 54 times.

With ordinary rice anthracite coal as a fuel these results are certainly very flattering. The boiler is simple, quickly and easily set, and the cost per horse-power is very low.

A simple method has been adopted for cleaning it. A steam jet has been arranged for each stack. Once a day steam is blown into the stack, which carries off all the dust which may have settled in the flues.—*Iron Age.*

Open Suburban Cars.—The Illinois Central car shops at Chicago are building several hundred open cars for the use of visitors to the Exposition. The car is designed to seat 110 persons comfortably, although at least 24 more average sized persons may be accommodated with seats. The length of the vehicle over all is 53 ft. and from sill to sill, 45 ft. 1 in. The width is 8 ft. inside and the height from rail to roof, 13 ft. 9¼ in. Across the ends of the car are seats, and there are, in the interior, 10 double-seated compartments. No steps or platform will be attached to the car, as the train will make no stops between Van Buren Street and the Exposition grounds, and the platforms at the terminals will be of the same height as the floor of the cars. In finish the coaches will be of the same style as the suburban cars.—*National Car-Builder.*

An Electric Locomotive.—Foreign papers state that a firm in Basle, Switzerland, is building an electric locomotive of 1,500 H.P. It will be carried on six wheels and will have three motors, one attached to each axle. It is expected to attain a very high speed.

THE RAILROAD AND ENGINEERING JOURNAL.

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NEW YORK, JULY, 1892.

WATER seems to have been an unusually destructive element this year. The floods in Pennsylvania are referred to elsewhere, and the people along the lower Mississippi have been and are still engaged in a prolonged effort to secure their levees from destruction by the river, which has been as high, or higher, than ever before. In some cases they have succeeded by hard and well-directed work, but in several places there have been dangerous *crevasses* which have flooded a large extent of country.

The question of holding the Mississippi in check and disposing of the flood waters grows more difficult every year; and it presents a problem which may require the best thought and ability of engineers.

IF the reports telegraphed to the daily papers be true, Dr. Justin has at last succeeded in his efforts to use shells loaded with high explosives with an ordinary gun and a powder charge. His latest tests are said to have had very successful results; but after the long series of failures in this direction some doubt may be expressed, at any rate, until fuller reports are made.

THE purchase of the Louisville, New Orleans & Texas Railroad by the Illinois Central Company is a railroad event of some importance, giving the last-named company control of two good north-and-south lines, and substantially freeing it from the competition of any strong line south of the Ohio. It is another step in that process of consolidation which is so marked a feature of the present railroad era.

THE Special Commission to which the Supreme Court, under the provisions of the law, referred the report of the New York Rapid Transit Commission, has submitted its report. This approves the plan for a four-track underground road through the center of the city as far north as Union Square, and thence up the west side to the city limits; the line in the upper part of the city to be partly under and partly above ground, according to the varying nature of the surface. The approval of the proposed east side line is limited to a road as far north as 44th Street, any action as to the rest being prevented by an act passed by the last Legislature prohibiting the use of Madison Avenue, which had been chosen by the Rapid Transit Commission.

The Court will probably keep this report under consideration for some time before deciding upon it. Should it be approved, the franchise for the proposed lines will be offered at public sale to any parties who will undertake to build and operate them.

IT now seems probable that the Ordnance Department of the Army will get a liberal appropriation for the completion of the gun factory at the Watervliet Arsenal. This factory has been well planned and managed, and the additional plant which the appropriation provides will put it in condition for doing good work on the largest class of guns.

THE New York Central has lately put in use on its suburban trains a number of locomotives burning anthracite coal, much to the relief of travelers and residents along the line. The use of bituminous coal with the accompanying smoke on locomotives running through such crowded residence districts as those along the Harlem Division and the lower end of the Hudson River Division is a "relic of barbarism" which ought not to be permitted. The new engines, by the way, are of the ordinary eight-wheel pattern, and not of the type illustrated in our columns some time ago, although those engines are said to have done very well.

THE Pennsylvania Railroad has had several locomotives built in different shops and of different styles, which are to be tried in its fast passenger service, in comparison with the established types now in use on the road. Two of these engines are from the Schenectady Works, one being an eight-wheel engine and the other a ten-wheel, two-cylinder compound; a third is a ten-wheel engine from the Baldwin Works, of the Vauclain four-cylinder compound type.

THERE seems to be some prospect of the completion of the Chigneto Ship Canal, and work on the hydraulic lifts at the northern terminus was recommenced early in June. The iron-work and machinery for this was completed some time ago. It is understood that the Company has secured means for going on with the work at any rate, if not enough to complete it.

THE Cape Cod Ship Canal project, which has been brought up so many times, and upon which work has been begun on several different occasions, has always been unfortunate, and notwithstanding the obvious advantages of the canal, no Company has yet succeeded in bringing it anywhere near completion. The latest corporation which has hold of the project tried to secure some aid from the State of Massachusetts, but the Legislature of that State has put so decided a veto upon it that there is no probability of the attempt being renewed.

OTHER ship canal projects, however, seem to promise better. Professor Haupt is sanguine as to the prospects of his proposed canal between the Delaware and New York Bay. His plan, it will be remembered, provides for the enlargement of a part of the present Delaware & Raritan Canal, which will cover nearly one-half the distance

and the building of a new canal for the remaining half; from an engineering point of view this is a perfectly feasible project, the only question being as to the commercial value of the canal when completed.

THE tests ordinarily adopted for color-blindness have never seemed to us altogether trustworthy; and although they have met with general acceptance, this opinion seems to be supported by the British Society of Arts. At a recent meeting of that Association, a paper on Color-Blindness was read, and in that paper and the discussion which followed strong ground was taken against the ordinary tests. Persons who had had considerable experience in making them maintain that on the one hand they could be used in an unfair way, while upon the other it was comparatively easy for a person with a little previous instruction to evade their requirements. A new and more satisfactory set of tests is recommended, athough experts are not agreed as to what programme should be followed.

THE project for an electrical railroad between Chicago and St. Louis, which is advocated by Dr. Adams, and to which some reference has heretofore been made, does not seem to meet altogether with the approval of the experts in the Electrical Engineers' Society. Dr. Adams recently delivered a lecture before that Society on his plan, which was sharply criticised, and some high authorities expressed serious doubts as to its practicability in the present state of the science, although few were willing to say that something like it might not be carried out in the future.

IT is stated that the Short Electric Company, of Cleveland, through its Engineer, has made a proposition to the Manhattan Elevated Railroad in New York for the running of its trains by electricity. The proposition, it seems, was not accepted, the Manhattan Company being somewhat doubtful as to the result, although the engineer who designed the proposed system was perfectly confident. To run the trains on the Third Avenue line of the road, for instance, would be a much greater undertaking than any electric company has yet ventured upon. As in the instance previously referred to, it would be rash to predict that it will not be done within a few years; but to judge only by what has already been accomplished, the Company seems to be justified in expressing some doubt as to the result. It may be said, however, that the New York elevated lines present about as favorable conditions as could be found for the use of electricity as a motor, and if the experiment could be tried there the results would be interesting.

IT is to be noted that both the great political parties this year have inserted in their platforms resolutions favoring legislation for the adoption of safety appliances on railroad cars. This is significant, because it shows a belief on the part of men who are accustomed to watch public opinion that there is a popular interest in the question which is worth considering. It will also serve to indicate the importance of railroads and railroad questions in modern life.

THE Government of the Argentine Republic has carried official regulation of railroads to a greater extreme, probably, than that of any other country, excepting, of course, those in which the railroads are owned directly by the State. As a general rule the interferences of the State is confined to the regulation of rates and similar matters, and to certain requirements intended to secure safety in operation, but the Argentine Government has recently gone much further. In one case we are told a large lot of rails imported for the use of one of the lines had been thrown aside because the Government inspectors refused to allow them to be laid, not because they were of poor material or too light, but because the section did not suit the views of the inspector. It is said that a plan is in preparation requiring all railroad lines to use rails of uniform section, and that the Government also proposes to adopt certain types of locomotives and cars to which all the roads must correspond. How far this will be carried is still uncertain, but it is quite possible that such unnecessary regulation may produce a reaction to the other extreme.

A NEW company, which has just been organized in New York, proposes to build a tunnel extending under the North and East Rivers from Jersey City to Brooklyn, and connecting the Long Island Railroad with the Pennsylvania and the other roads having their terminal stations on the west side of the Hudson. The articles of incorporation also contain clauses providing for the underground connection of both Brooklyn and Jersey City with the lower part of New York City. But little has been said about this company, but it is reported to have the backing of Mr. Austin Corbin and some other heavy capitalists who are quite able to provide the means for carrying it through.

THE SIBERIAN RAILROAD.

THE actual commencement of work on the Western Siberian Railroad is an event which ought to attract attention all over the world. As our Russian correspondent tells in another column, the location of the road has been finally approved, and an appropriation made which will put the graders at work. Although it is now too late in the short Siberian season to accomplish very much this year, it is an earnest of the future, and there is no doubt that next year substantial progress will be made.

The Siberian Railroad has several features which ought to draw attention to the work. In the first place, it will be the longest continuous railroad line in the world. It is the only great transcontinental line now under construction, if we except the comparatively very short Transandine Railroad in South America, and it presents many engineering features of interest. The building of the road through the difficult mountain region of the Trans-Baikal; its operation in the rigorous climate of Eastern Siberia, and the crossings of a number of rivers of great size are all points which will require much engineering skill and ability.

The commercial results of the building of the road may also be considerable, and may tend to make considerable changes in some old trade routes. It will take time to accomplish these, however, even after the road is completed, for trade changes slowly although surely.

It must also be remembered that Western Siberia now presents the only great unoccupied area of land which is open to occupation and cultivation by civilized man, for the tropical regions of Africa can hardly be considered in such a connection. The climate is not more severe than

that of Manitoba or perhaps North Dakota, and much of the land is of good quality. Central Siberia can never be an agricultural country, but it has great resources in minerals and timber which the railroad will develop. On the Pacific end of the road there is a very fertile country still almost unoccupied, which presents many inducements for settlement.

Finally the road will so strengthen the military position of Russia as to make that State the dominant power in Eastern Asia, and to give it a position like that it already holds in Central Asia, a controlling influence which no other European power can shake.

All these are considerations which will doubtless fully support the Russian Government in its intention to build the railroad with all possible speed. It is interesting to know that American ingenuity is appreciated by the Russian engineers, and that American methods and machinery will be largely adopted in construction.

DAMS AND FLOODS.

Our readers are all familiar through the daily papers with the details of the flood in the Oil Creek Valley by which the flourishing towns of Titusville and Oil City in Pennsylvania were recently almost destroyed, and the circumstances seem to call for some comment. The catastrophe there was only second to the memorable one at Johnstown in its terrible results, the loss of life and the devastation of a prosperous district, while in the towns themselves the horrors of a fire, spread and carried on by the water itself, were added to the flood. That the loss of life was not as great as at Johnstown was due chiefly to the fact that the wider spread of the valley did not permit so great a concentration of the flood, and gave more time and opportunity for escape.

While there would probably have been some damage done in any case by the overflow due to long-continued heavy rains, it would probably have been so limited in its nature as hardly to attract any special notice, had not the flood been concentrated in its effects, as it were, by the addition to it of the water stored up by a dam at Spartansburg, on the upper waters of the stream. A great body of water was here held in check and was then suddenly set free by the breaking of the dam, and rushed down the valley with a force which carried everything before it.

This dam seems to have been a structure hardly sufficient for its purpose in ordinary seasons, and certainly not to be relied upon in one like the present. It was, apparently, an earth and rock dam built up in a haphazard sort of way, and added to from time to time as more storage of water seemed desirable. It had certainly not been built or maintained with any special care, and no one seems to know just what was expected of it, or what its real condition was. Probably the forces before which it finally gave way had been acting for some time, and its failure was simply a question of days.

Two points seem to be impressed upon us by this affair. The first is the old axiom which cannot be too often impressed upon the builders and owners of dams—engineers may be supposed to know and realize its importance—that "the overflow *must* be sufficient to carry off any surplus of water and prevent any rise from overtopping the dam. No earth dam can long withstand the running of water over its crest, which is surely fatal to the structure."

In this case the water seems to have risen above the crest--the dam was already leaking—and after that the utter failure was a question only of time, and of a very short time.

This lesson was further impressed upon us a week or two later by a nearly similar failure of an earth dam, and by the following flood, which almost destroyed the mining town of Mahanoy City, in Eastern Pennsylvania. In that case the element of fire was absent, but serious loss of life was prevented only by the presence of mind and prompt action of two or three men who saw that the dam was giving way, and warned the people of the valley below.

The number of dams and reservoirs in nearly all the States is increasing constantly with the increased demand for water power and for storage for city and town supplies and for irrigation. It is clearly a duty, in the interest of public safety, to insist upon a careful supervision of the construction and maintenance of such structures. This duty has been too much neglected in the past, and there are not more than three or four States in which there is even any systematic attempt at proper control, while in many of them it is ignored altogether.

An incidental lesson from the Oil City catastrophe is that greater care should be exercised in selecting places for tanks and storage of oil in bulk. The near neighborhood of such tanks to towns and villages must be always a source of danger, and their location should be so chosen that the least possible damage may result in case of fire or failure of a tank. They should also be scattered as much as possible, so that accident may be confined to a single tank, and its extension to a great body of oil avoided.

THE MASTER CAR-BUILDERS' CONVENTION.

The inexorable calendar has again brought around the dates when the masters of car-building, with their wives and daughters, are in the habit of flocking together at some extensive and more or less agreeable hotel where entertainment can be provided for some hundreds of people who annually attend these meetings. This year the place selected was Saratoga, which is, perhaps, better suited than any other for the holding of such meetings. The time when they are held—about the middle of June—is before the opening of the regular season at the great hotels, so that there is always room and to spare for all who come. There are few attractions besides the meetings sufficiently alluring to entice members away from them, so that there is nearly always a better attendance when the conventions are held in Saratoga than there is in any other place. The aperient effect of the waters also seems to assuage animosities, so that the amity of these assemblages is less disturbed here than it is elsewhere.

There was nothing especially notable in the journey from New York to Saratoga, which was made on the celebrated Empire State Express as far as Albany, excepting to note the success of this celebrated train. All the seats, excepting an uncomfortable one in the corner of the smoking compartment, were taken the night before the departure of the train, and all the other cars were filled. It was predicted of this train that it would not pay, but it is said to be one of the best-paying passenger trains on the New York Central Railroad. Of the run not much is to be said. It is not uncommon to travel even on local trains at speeds quite as high as this train attains, and it is also not unusual, on limited trains, to run long distances, at limited speed, without stopping ; but the Empire State Express runs without stopping the whole distance from New York to Albany, and keeps up a high rate all the way.

A little criticism of the drawing-room car would, perhaps, not be out of place here. The writer was unfortunate in securing

a poor seat on the sunny side of the car. The window-shade was of the usual textile material used in drawing-room and sleeping cars, and was hot and stuffy. It was not clean, and excluded the air, which leads to the remark that old-fashioned blinds with slats are in every way to be preferred to such shades. The blinds are cleaner, cooler, and permit of free circulation of air when the windows are opened. It has been a fad of late years to substitute shades for blinds on the ordinary coaches of some roads. The old-fashioned practice seems in every way to be preferable to the new innovation.

Another practice may also be noted as an advance backward —the omission of parcel-racks in drawing-room cars. This was done because such conveniences were not considered elegant, and it was thought that they detracted from the stylishness of such cars, the attainment of which end seems to be the pre-eminent motive in their construction. Hooks were provided in place of racks, on which to hang hats and coats, with the result that in cold, and even in mild weather, the interiors of these cars bear a resemblance to second-hand clothing shops. Give us the basket racks, Messrs. Car-Builders, and omit the coat and hat hooks, and your cars will gain in comfort more than they lose in tonicity.

The Association held its first meeting in the ball-room of Congress Hall, the acoustic properties of which, by the way, are wretched. The meeting was called to order by the President, John Kirby. The usual welcome by the Mayor of Saratoga, President's address, and report of Secretary were delivered, and the Convention then set sail. Since last year there was a net increase of 14 members and of 68,075 cars represented. The Treasurer's report shows a balance to the credit of the Association of $4,184, a more favorable condition of finances than has ever existed heretofore.

Abstracts of the various reports are given on another page, so that no effort will be made here to summarize them. The discussion on the Rules of Interchange was unusually protracted, and, owing to the warm weather, rather fatiguing to the members. It was at times, too, a little acrimonious.

Standard gauges for the preservation of the contour lines and thickness of the metal of the M. C. B. couplers which were ordered by the Executive Committee were submitted to the Association by the Pratt & Whitney Company, of Hartford, Conn., and the question of the adoption of them as standards was submitted to a letter ballot of the Association.

Among the significant events of the meeting was the invitation from the Superintendents' Association, asking the M. C. B. Association to send delegates to the meeting of the former. In this letter the hope is expressed that the step thus taken "may lead to mutual benefit and to an increase in usefulness of the railroad service as well."

Of the meeting generally it may be said that the attendance was larger than ever before. This is true of the members and of the "lobby" as it is called—that of persons indirectly interested in the sale and manufacture of supplies and machinery. Never before was there so much interest manifested in the proceedings. Two sessions a day were held, and on Friday afternoon it was plain that there would not be sufficient time for a proper consideration of some of the reports. One of these, on the Standards of the Association, was one of the best ever presented to the Association, and deserved a long and careful discussion. To the older members it seemed like breaking up long and cherished religious belief to propose that some of the standards should be rescinded. Around nearly all of them there clusters in the minds of the older members the recollection of a struggle more or less earnest, of discussions and argument of which the newer members are ignorant. The Committee, however, did their work so well that all who heard their report seemed to be agreed that their recommendations to rescind and modify some of the standards ought to be carried out. The discussion was, however, postponed to the meeting next year, and then the subject will doubtless be fully considered.

To the older members who have attended these meetings for twenty or more years, their gradual growth and importance is very interesting. It was only a few years ago since the effort was made to induce the railroad companies of the country to send representative members to these meetings. It then seemed to be very doubtful whether any sufficient number would accede to that request, to make the measure successful. Now the usefulness of the Association is established to such a degree that people inquire how could the business pertaining to the construction and movement of cars be carried on without it? That it has a great career of usefulness before it no one any longer doubts.

THE MASTER MECHANICS' CONVENTION.

Like the Master Car-Builders, the Master Mechanics' Association had a large attendance at its Saratoga meeting. The proceedings were fully up to the usual standard, and there were several interesting discussions.

Perhaps the most important and interesting report presented was that on Compound Locomotives, which was the result of much work on the part of the Committee. With the arrangements made for the use of a compound engine for tests our readers are already familiar, and the report gives an account of the experiments made with this and other engines, the results being presented as fully as possible. The Committee has not felt fully prepared to analyze the results as presented, but the general tenor of its remarks seems to be that the economy in fuel obtained with the compound engine was not so great as had been expected, and was hardly up to the point claimed by its advocates.

The tests made directly under the supervision of the Committee are supplemented by some short reports of tests made by other members of the Association. The report was very fully discussed in the Convention, with the probable result that more service trials will be made. After all, the determination of the true value and place of the compound is not a question of a few tests, but of continued use in regular service, where its cost for repairs as well as for fuel, and the work which it can do will be decided.

The Convention labored under the disadvantage of very hot weather, which does not tend to stimulate the members to much exertion; but on the whole it was a very good one, and will compare not unfavorably with its predecessors.

NEW PUBLICATIONS.

The Memphis Bridge; Superstructure and General Plans. By George S. Morison, Chief Engineer. The Kansas City & Memphis Railroad & Bridge Company, Memphis, Tenn.

Mr. Morison, the Chief Engineer of the Memphis Bridge, the completion of which was recently noted, has issued an album under this title containing a number of sheets showing the general plan and much of the detailed work of the different spans of the bridge. The lithographic sheets are 44 × 19 in. in size, so that the drawings are on a fairly large scale and are easy to read. The Memphis Bridge possesses great interest on account of the extraordinary length of the spans and the many difficulties overcome in its construction, and these illustrations of the manner in which the work was done will be of much interest to engineers.

Railway Officials' Directory and Guide for the Use of Railroad Men and Dealers in Railroad Supplies. The *Railway Age* Publishing Company, Chicago, Ill.

This is a new edition of the book which has been published for several years under the title of the "Supply Men's Direc-

tory." It gives the names and addresses of the principal officers of the railroads of the United States, Canada and Mexico, the list including the presidents, general managers, superintendents, purchasing agents, chief engineers and the heads of the motive power and car departments. It is a little book of 180 pages, of convenient form to carry in the pocket, the size being $3\frac{1}{4} \times 5\frac{1}{2}$ in. The type is necessarily rather small, but is not difficult to read, as the printing and paper are good. So far as we have been able to examine, it is carefully prepared and correct, and it is certainly a convenient and handy book for a traveling man to carry with him. An index showing the places at which different roads are represented adds to its convenience.

SUPERIOR, THE EYE OF THE NORTHWEST. ANNUAL REPORT OF THE CITY STATISTICIAN OF SUPERIOR, WISCONSIN. W. F. Street, Statistician. Published by the City, Superior, Wis.

In this pamphlet Mr. Street has grouped a large collection of figures showing the growth of the City of Superior in trade and manufactures, and giving also some information about the trade of the Northwest which, it is hoped, will be brought to that city. The many advantages of the place and the certainty of its future growth and development are also set forth.

The information is well arranged and presented, and the pamphlet is illustrated by views of some of the notable buildings, hotels, factories and others.

COMPOUND LOCOMOTIVES. The Schenectady Locomotive Works, Schenectady, N. Y.

This pamphlet contains a paper written by Mr. C. H. Hudson, General Manager of the East Tennessee, Virginia & Georgia Railroad, describing a practical test of compound locomotives in regular service. The locomotives with which the test was made were of the two-cylinder type made at the Schenectady Works, one of them being a ten-wheel passenger engine, and the other a heavy consolidation freight engine. Both were tried in comparison with simple engines of the same classes in all respects, except the cylinders, and in both cases the results were very favorable to the compounds.

The pamphlet contains, besides this paper, a description and drawings of the Pitkin intercepting valve, which is used on the Schenectady engines, and engravings of a number of compound locomotives built for different roads. There are also given a number of indicator cards taken from an engine built for the Adirondack & St. Lawrence Railroad, which was tried on the New York Central, and did some excellent work.

TIMBER PHYSICS: PART I, PRELIMINARY REPORT. B. E. Fernow, Chief of Forestry Division, Department of Agriculture. Government Printing Office, Washington.

Reference has been made in our columns from time to time to the important series of tests of strength and other qualities of timber undertaken by the Forestry Division of the Department of Agriculture. The present volume is the first report on these tests and consists of three parts. The first gives a short introduction and a number of opinions on the value of such tests. The second shows the scope and historical development of the science of Timber Physics, with references to European and American works on the subject. The third part gives an account of the methods pursued in making the tests now in progress, and is accompanied by illustrated descriptions of the machines used for the purpose.

No results are given, for the reason that the tests have only just been begun, and the results obtained are to be announced from time to time, as progress is made in the work. The report gives a fair idea of what has been undertaken and what is expected in the future.

THE RAILROAD LAW OF THE STATE OF NEW YORK. Compiled by R. C. Cumming and Michael Danaher, 1892. James B. Lyon, Albany, N. Y.; price, $1.

This must be an interesting and convenient volume not only for lawyers, but railroad managers and officers, and to some extent for that very large class of persons who are simply investors in railroad property. Its object is to give in a convenient form the complete code of law of the State of New York relating to railroads, as it stands at the present time. It contains the general law governing corporations, the stock corporation law, the general railroad law of the State governing all railroad corporations and officers, the law relating to the condemnation of property for railroad purposes, and such sections of the general code, the civil code, and the criminal code as relate to railroads, their officers and employés. Two supplements contain, one the Rapid Transit Act of 1891, which governs the construction of local roads in large cities, and the second the Federal Interstate Commerce law, which is a very convenient supp ement to a book intended for railroad officers.

The amendments are all brought down to include those made at the legislative session of the present year, and lists are given of the laws formerly in force which have been repealed. The book is completed by a very full index by subjects, so that it is possible to find quickly the sections relating to any given point. While the reviewer is not a lawyer, it may be said that a careful examination of the book seems to show that the work has been thoroughly done, and that it is what it professes to be—a full compendium of the laws governing the railroads and their officers in the State of New York as they stand at the present time. A reader need hardly be told how useful and even necessary such a volume is.

WROUGHT IRON AND STEEL IN CONSTRUCTION. CONVENIENT RULES, FORMULÆ AND TABLES. The Pencoyd Iron Works; A. & P. Roberts & Company, Philadelphia.

The eighth edition of this useful hand-book has been rewritten and altered materially since the first edition was issued eight years ago, in order to meet the changing requirements of engineers, in consequence of the changes in methods of design and strength of material. The tables have been enlarged to include steel as well as iron, and much additional matter has been added.

The rules and tables given apply only to shapes made at the Pencoyd Works, but these are so various and cover so many forms—almost every kind ordinarily used in construction—that they may be said to be of general application.

The book seems to have been very carefully prepared, and eight years of application have made it possible to amend any errors and supply any deficiencies which might have existed in the first edition. It is certainly a very convenient addition to an engineer's library, and will save him much time and trouble in his calculations.

REPORT OF TESTS OF COMPOUND LOCOMOTIVES. Burnham, Williams & Company, The Baldwin Locomotive Works, Philadelphia, Pa.

This pamphlet contains a report of four tests of compound locomotives of the Vauclain pattern made at different times in comparison with simple locomotives as nearly of the same class and description as possible. The first one referred to was made on the Northern Pacific Railroad, and was of a mogul engine having $11\frac{1}{2}$ and 19×24-in. cylinders, which was tried in connection with an engine of the same type having 18×24-in. cylinders. The other tests were made on the Western New York & Pennsylvania, the Western Maryland and the Norfolk & Western roads.

The report is illustrated and accompanied by numerous tables showing results of tests and by a number of indicator diagrams taken during the tests.

TRADE CATALOGUES.

Description of Vauclain Compound Locomotives, with Suggestions for Conducting Simple Fuel Tests. Illustrated. The Baldwin Locomotive Works, Philadelphia.

This pamphlet contains a fully illustrated description of the Vauclain four-cylinder compound locomotive, the cuts showing all the details, and some account of what has been already done with this type of locomotive. It has also some useful suggestions as to the best methods of making fuel tests of locomotives in actual service.

Creosoted Piles and Timber for all Purposes; the Dead Oil of Coal Tar Process. The Eppinger & Russell Creosoting Works, Long Island City, N. Y. Illustrated.

This pamphlet gives an account of the process named for preserving timber, and is illustrated by views of specimens of treated timber after long use, contrasted with others of untreated timber with the same exposure. This process has been applied to piles, paving-blocks, ties and other timber in exposed situations, and to timber blocks employed in making underground conduits for electric wires.

Efficient Power Pumps for Every Service, and their Applications Illustrated. The Goulds Manufacturing Company, Seneca Falls, N. Y.

This handsome catalogue gives a description of several patterns of power pumps—that is, not steam pumps, but pumps driven by belts, gearing, or electric motors—and a number of illustrations showing the purposes to which they are applied for mines, factories, elevators, etc. The descriptive matter gives a clear idea of the machines and their use, and it is well supplemented by the illustrations.

Riehlé Brothers' Testing Machine Company: Illustrated Catalogue. Philadelphia.

This little volume is to be considered, the publishers say, as a memorandum, not a price-list. It gives brief illustrated accounts of the articles manufactured by the Company, which include testing machines of different kinds and of large and small capacity; hydraulic pumps; hydraulic presses; hydraulic jacks; screw and power presses for different purposes; rope-twisting machines; dynamometers; trucks and barrows of every kind; and a great variety of smaller articles for special uses, besides hoists, chains and ventilating fans.

Engineers' Handbook of Standard Wood-Working Machines. The John A. White Company, Dover, N. H.

This little book, which is of convenient size to slip into the vest-pocket, gives illustrated descriptions of some 50 different wood-working machines made by the White Company, including saws, planers, borers, mortising machines and other tools. It is neatly printed and convenient for reference.

The Berlin Iron Bridge Company's Catalogue. Office and Works, East Berlin, Conn.

The purpose of the publishers of this catalogue is stated in an introduction to it, in which it is said that

> It is our intention in this catalogue to illustrate the construction of a large number of manufacturing buildings which we have built in the last few years. Some of these are large, some small, but we have tried to illustrate all the different classes and conditions which are likely to arise. All of these illustrations are taken from photographs, or from the working drawings of the structure as actually built. The catalogue itself shows an experience in this class of work which has never been attained by any other company.

The book is 10 × 10 in. and contains 103 pages and about the same number of engravings, most of them showing the interiors of buildings constructed by this Company. Some are scale drawings showing the roofs and other portions of buildings. The engravings are made by some photographic process from pen and ink drawings. The back portion of the book contains perspective views of a number of highway bridges of the "parabolic truss" form, which is a specialty with this Company. Several railroad bridges and a view of the works complete the volume.

This Company makes a specialty of iron buildings, and the illustrations show examples of forge shops, ship-sheds, electric-light stations, paper and pulp works, brass and copper works, armories, iron and coal sheds, copper casting shop, bending shed for shipyard, machine shops, foundries, water works, rolling mills, arcade for railroad platform, and many others.

The book gives an excellent idea of the work done by the Company, and the extent to which iron and steel are now employed in the construction of buildings.

The Stow Flexible Shaft. Illustrated Catalogue of the Stow Manufacturing Company, Binghamton, N. Y.

This catalogue gives a description of the well-known flexible shafting made by the Stow Company, with accounts of a number of its applications in general use. It also describes a number of tools made by the Company, most of them being intended for use with the flexible shafts. We hope to refer to this catalogue more at length hereafter.

Catalogue of Presses, Drop-Hammers, Shears, Dies and Special Machinery. The E. W. Bliss Company (Limited), Brooklyn, N. Y.

This catalogue is received too late for the special notice which its importance and excellence deserve.

Catalogue of Drawing Instruments. Illustrated. The Ball Ball Company, Frankford, Philadelphia.

Rapid Lathe Work by a New Method: the 2 × 24 Flat Turret Lathe. Illustrated. The Jones & Lamson Machine Company, Springfield, Vermont.

CURRENT READING.

In Good Roads for June there is a paper giving the history of our First Artificial Road; articles on Asphalt and its Uses; on the Streets and Roads of Washington; on Preserving the Carriage; and the continuation of Editor Potter's excellent articles on Dirt Roads and Gravel Roads.

The June number of the Eclectic Magazine has an usually interesting selection of articles from the English magazines and reviews, including both lighter matter and more serious articles.

The July number of Scribner's Magazine is a summer number, and is appropriately given up chiefly to lighter reading. There are, however, several interesting articles of a more serious nature, including one on the Poor of Chicago, by Joseph Kirkland, and one on the Resumption of Specie Payment, by Hon. John K. Upton.

The June number of the Arena covers a wide range of subjects discussed by capable writers. Among them are the Public School System, Life Insurance, the Basis of Currency and others. There is an excellent historical article on the Swiss Lake Dwellers, and Professor Dolbear writes of some of the newly discovered properties of matter to which Mr. Tesla's experiments have called attention.

A new periodical is issued by the D. H. Ranck Publishing Company, of Indianapolis, under the title of Milling. The first number—for June—is in magazine form, has 124 pages,

handsomely printed and illustrated, and contains a number of interesting articles. It is to be devoted to the flour and milling industry as a specialty, and ought to be successful.

A new enterprise, started in Boston, is the WEEKLY BULLETIN, which gives each week a classified index of articles from the periodical press, including in its list scientific and technical journals, as well as those of more general interest. Although still in its first volume, the paper has been very successful. Its value to readers, writers, and students will be readily seen.

The STREET RAILWAY GAZETTE has passed into the possession of Mr. M. J. Sullivan, who is now editor and publisher, and has full control of the paper. It is an excellent representative of its special interest, and its appearance under the new management in an improved form will add to its attractive character. We wish our contemporary the success which it well deserves.

The fifteenth article in the POPULAR SCIENCE MONTHLY'S series on the Development of American Industries since Columbus, is published in the July number. It is on Leather-making, and, like all in the series, it is fully illustrated. Other leading articles are on Anthropological Work in America, and on Manual Training and Industrial schools, and there are several shorter papers of interest.

The latest issue of the NATIONAL GEOGRAPHIC MAGAZINE contains a very interesting account of an expedition into the Yukon District in Alaska, by Charles Willard Hayes. It is accompanied by several maps showing the topography of this almost unknown region.

The June number of OUTING opens with a beautifully illustrated article, Through Muskoka Marvel Lands, by Edward W. Sandys, in which the author draws a charming picture of holiday life, scenic beauties and black bass fishing, in one of Canada's loveliest regions for summer residence. The number is well illustrated and excellent throughout. The Maryland National Guard, by Hanson Hiss, is concluded, and forms an interesting addition to the series of military articles published in the magazine. The number is excellent summer reading.

In recent numbers of HARPER'S WEEKLY there have been excellent illustrated articles on Nicaragua ; on the Chicago Exposition Buildings ; on Colorado and the Great Divide ; on the Floods in the West, and on the Transandine Railroad.

The June number of the ENGINEERING MAGAZINE presents a long and varied table of contents, as follows : New York's Commercial Blight, W. N. Black ; the Future World's Highway, T. G. Gribble ; Sanitary Progress in New York, C. F. Wingate ; Creede, the New Mining Camp, A. Williams, Jr. ; Engineering at Ropes' Pass, Texas, William Kent ; the Modern Marine Boiler, A. B. Willitts ; Testing Guns at Sandy Hook, F. A. C. Perrine ; the Railroads and Wall Street, T. L. Greene ; Practical Work at a Mining School, E. S. Cranson ; Impending Disaster on the Mississippi, a Southern Engineer ; Practical Hints on Heating, L. Allen. The special departments show a great improvement under the new editors.

The April number of the SCHOOL OF MINES QUARTERLY has, among other articles, papers on the Topographical Survey of New York, by Professor Trowbridge ; a Formula for Water Power, by the same author ; the Pyrometer of M. le Chatelier, by Joseph Struthers ; the Path of a Locomotive Crank-pin, by George F. D. Trask.

The May number of the JOURNAL of the American Society of Naval Engineers has articles on the Screw Propellers of United States Naval Vessels, by Passed Assistant Engineer H. Webster ; Method of Molding a Cylinder at the Bath Iron Works, by Assistant Engineer S. H. Leonard ; Pumping Plant for the Salt Water Aquaria at Chicago, by Passed Assistant Engineer W. B. Bailey ; Proposed Revision of Rules of the Steamboat Inspection Service, by Passed Assistant Engineer Walter M. McFarland ; besides a variety of notes of interest.

The July number of HARPER'S MAGAZINE has an unusual number of fine illustrations. The season is observed by several articles appropriate to the National anniversary. The series of papers on the Danube is continued by one describing the little known region of the Roumanian plains. Another article describes the western frontier of Russia, and for students of politics there is much interest in a paper on the Growth of the Federal Power, by Mr. Henry Loomis Nelson.

The OVERLAND MONTHLY for July is an excellent number, and contains several valuable articles, besides the usual variety of light reading.

The June number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE has articles on a variety of topics, including the Underground Drainage of Florida ; the Nicaragua Canal ; Maps and Map Drawing ; Glacial Phenomena ; and Standard Time. There are others of almost equal interest, making a number fully up to the standard.

The latest number of the PROCEEDINGS of the United States Naval Institute has articles on the Driggs-Schroeder Rapid-fire Gun ; Organization of Naval Engineer Forces ; the Signal Question ; Statics of Launching ; Literature of Explosives ; and a variety of professional notes of interest.

The JOURNAL of the Military Service Institution for May has a continuation of General Tidball's paper on Artillery in the Rebellion, and articles on the Military Geography of Canada ; a Plea for the Colors ; Diseases Epidemic in Armies ; Post Schools ; and several reprints and translations from foreign sources.

The JOURNAL of the New England Water-Works Association for June has much to interest the engineer, including a series of short "Experience Papers" on various questions arising in connection with water-works management.

The April number of the LEHIGH QUARTERLY has articles on Water Cooling Appliances at a Blast Furnace, by F. S. Du Pont Thompson ; Boiler Waters and Incrustation, by Alban Eavenson ; Manufacture of Heavy Ordnance and Armor Plate, by R. R. Hillman ; the Durham Mines, by Heber Denman ; and the Theory of Centrifugal Ventilating Fans, by John T. Hoover.

BOOKS RECEIVED.

Transactions of the American Institute of Electrical Engineers. March : Lightning Arresters and the Discovery of Non-Arcing Metals. April : Methods of Electrically Controlling Street Car Motors. Published by the Institute, New York.

Census of Canada, 1891. *Bulletin No. IX : Religions.* Department of Agriculture, Ottawa, Canada.

Quarterly Report of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months Ending December 31, 1891. S. G. Brock, Chief of Bureau. Government Printing Office, Washington.

Wreck Chart of the Great Lakes ; Showing the Location of Wrecks from Founderings, Gales of Wind, Fogs and General Stormy Weather Conditions from 1886 *to* 1891. United States Department of Agriculture, Weather Bureau. Washington.

Selected Papers of the Institution of Civil Engineers. Published by the Institution, London, England. The present instalment of these papers includes Rochemont on Portland Cements at Havre ; Michaelis on Portland Cement in Sea Water ; Bamber & Carey on Portland Cement ; Smith on Portland

Cement Concrete; Matthews on the Southampton Water Works; Gill on the Sale of Water by Meter in Berlin; Beare on Building Stones of Great Britain; Airy on Weighing Machines; Fox on the Hawarden Bridge; Manby on the Arauco Railroad and Bio-bio Bridge.

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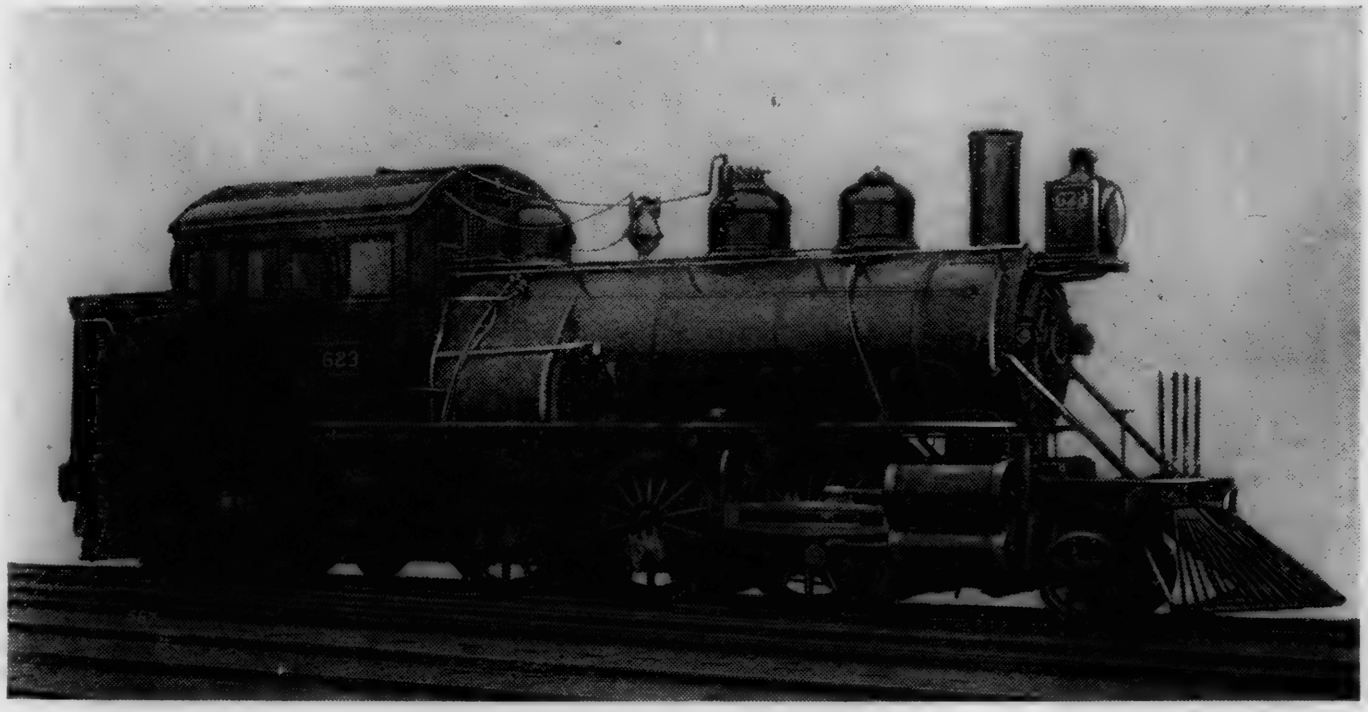

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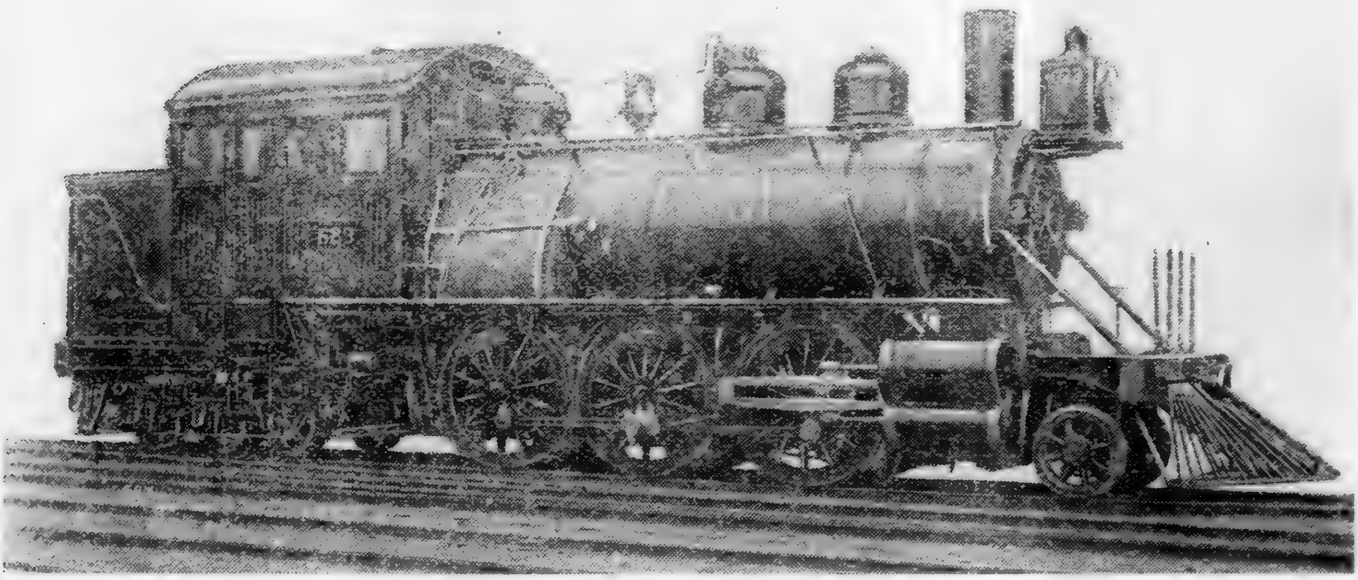

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The engine has the Westinghouse automatic brake, including driver brakes. Although built for the Philadelphia & Reading, the engine shown in the photograph has been for some time in use on the Illinois Central, running suburban trains out of Chicago. Its use there has been experimental, to test the use of waste anthracite for the possible reduction of smoke.

TRANSITION CURVES—CORRECTIONS.

To the Editor of The Railroad and Engineering Journal:

I SEND you an examination of the "Short Rule for Transition Curves," published in the JOURNAL of April, 1892. In this reference is made to figure and notation therein employed. The figure is reprinted herewith.

That rule directs that the ordinates shall be proportional

to the cubes of the abscissæ; in other words, that we use the cubic parabola.

The equation of this curve is: $y = kx^3$ (1) where k is a constant. Its total curvature, $\tan.^{-1} \dfrac{dy}{dx} = \tan.^{-1} (3\,kx^2)$. (2)

Its radius of curvature,

$$\frac{\left[1 + \dfrac{dy^2}{dx^2}\right]^{\frac{3}{2}}}{\dfrac{d^2y}{dx^2}} = \frac{[1 + 9\,k^2x^4]^{\frac{3}{2}}}{6\,kx}. \quad (3)$$

When $y = O$ (4), then by "short rule" $x = \dfrac{O \times 17000}{D\,T}$. (5)

Substituting (4) and (5) in (1) gives $k = \dfrac{D^3\,T^3}{O^2\;17000^3}$. (6)

Substituting (5) and (6) in (2) and (3) gives for Mr. Ward's curve:

$$\text{Total curvature} = \tan.^{-1} \frac{3\,D\,T}{17000} \quad (7) \text{ and}$$

$$\left.\begin{matrix}\text{Radius of curvature}\\ \text{at its terminus}\end{matrix}\right\} = \frac{O\left[1 + 9\left(\dfrac{D\,T}{17000}\right)^2\right]^{\frac{3}{2}}}{6\left(\dfrac{D\,T}{17000}\right)^2}. \quad (8)$$

Now, suppose we offset P. C. "to any extent," say 70.77 ft., and run in a 10° curve; then measure from P. C. "to any point," say 50° or 500 ft., and measure ordinate O, which will be 275.44 ft. Now substitute $D = 10$, $T = 500$ and $O = 275.44$ in (7) and (8), and we have for the case before us:

Total curvature = 41° 25′ 25″, instead of 50°, and radius of curvature = 1258.74 ft., corresponding to a curve of 4° 33′ 07″ instead of 10°. In this case, then, we have at the union of the two curves a *jump* of 5° 26′ 53″ in *degree of curve* and a *break* of 8° 34′ 35″ in *direction*. Evidently this "short rule" has not that wide application that its wording would seem to indicate, and it might be well to add another to hold the young engineer within the limits beyond which it is *not* "sufficiently correct." The *Transactions* of the Technical Society of the Pacific Coast contains the curve that is not hampered by limit of application, and which is *exactly* correct.

IRVINGTON, CAL. D. E. HUGHES.

A LOCOMOTIVE PROBLEM.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

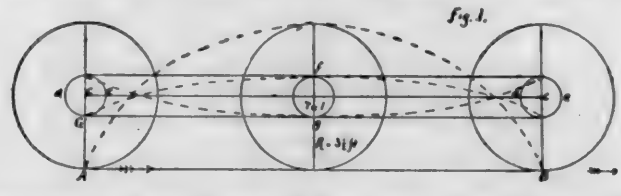
PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

To this problem the following answers have thus far been received:

I.—BY SETH PRATT, ASSYRIA, MICH.

In the diagram given, fig. 1, let $A\,B$ = the circumference of the driving-wheel, or distance passed over during one revolution. $R = 3\frac{1}{2}$ ft. = the radius of the wheel; $r = 1$ ft. = the distance of the crank-pin from the center of the wheel. A point at G during one revolution of the



driving-wheel will describe two cycloids, one above the center line $C\,C$ and the other below it; each having a height of 2 ft. and base equal to the circumference of the wheel. When the crank-pin is at the dead points d or e, the velocity of the piston will be equal to that of the locomotive, or 60 miles per hour. When one-quarter of a revolution is made and the pin is at f, its motion will be direct and we have $R : R + r$ :: 60 miles : $77\frac{1}{7}$ miles = the maximum velocity of the piston. When three-quarters of a revolution is made and the pin is at g, we have $R : R - r$ :: 60 miles : $42\frac{6}{7}$ miles = the minimum velocity of the piston.

II.—BY D. E. HUGHES, IRVINGTON, CAL.

It is evident that the crank-pin has the greatest *horizontal* movement, relatively to the *locomotive*, when it is at the *highest* and *lowest* points, and that at the *instant* of passing these points the *consecutive* positions of the connecting-rod are parallel. Hence at these times the velocity of the piston is *equal* to that of the crank-pin, or *maximum*; which in this example, where the diameter of the crank-pin's path is 2 ft. and that of the wheel is 7 ft., is $\frac{2}{7}$ of 60 miles per hour. Hence the maximum velocity of piston relative to *ground* is $\frac{9}{7}$ of 60 and the minimum is $\frac{5}{7}$ of 60.

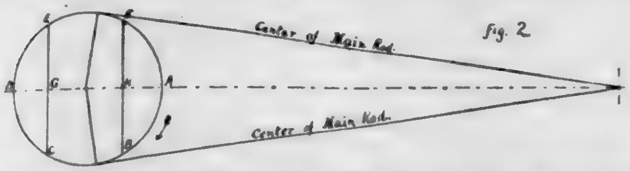
To look at this last point another way: the *bottom* of the wheel is *still*, its axle, $3\frac{1}{2}$ ft. above, has the velocity of the train; then points $2\frac{1}{2}$ and $4\frac{1}{2}$ ft. above the bottom move forward with $\frac{5}{7}$ and $\frac{9}{7}$ of 60 miles, or $42\frac{6}{7}$ and $77\frac{1}{7}$.

III.—BY W. H. TRETHEWEY, STRATFORD, ONT.

Of this problem I beg to submit to you the following solution: At 60 miles per hour the locomotive is moving with a velocity of 5,280 ft. per minute, or 88 ft. per second. The number of revolutions that the driving-wheels will make in any given time = the quotient of the circumference of the driving-wheels into the distance the locomotive moves in that time. Calling the circumference of the 7-ft. wheels 22 ft., which is within $\frac{1}{8}$ in. of the closest mathematical approximation, we find that the driving-wheels make exactly four revolutions per second, or one revolution per quarter second. For each revolution of the driving-wheels the pistons must travel two strokes—a forward and a backward—or 4 ft. per quarter second, or 16 ft. per second, which is the mean velocity of the piston with regard

to the locomotive, not with regard to the earth. But the velocity of the piston is a constantly varying quantity.

In the circle, *A B C D E F*, fig. 2, which represents the path of the center of the crank-pin, $A\ D =$ the piston stroke. As the driving-wheels move with uniform velocity, the crank-pin will move from *A* to *B*, from *B* to *C*, and from *C* to *D* in equal periods of time. But while the crank-pin moves from *A* to *B* the piston moves only the



distance from *A* to *H*, and while the crank-pin moves from *C* to *D* the piston moves only the distance from *G* to *D*, in these cases not regarding the angularity of the main rod. Now the distance $A\ H +$ the distance $G\ D =$ the distance $H\ G$; therefore the piston moves one-half of its stroke—viz., from *H* to *G*—in one-third of the time it requires for its full stroke. We have seen that the piston's mean velocity is 16 ft. per second, but its velocity between *H* and *G* must be at the rate of 8 ft. in one-third of a second, or 24 ft. in one second.

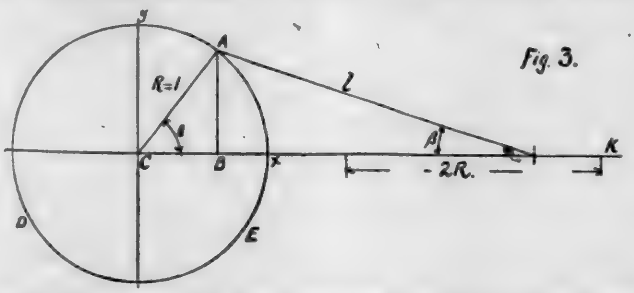
This, however, is not the piston's maximum velocity. It moves at its maximum velocity at the instant, and at that instant only, when the center line of the main rod becomes tangent to the crank-pin circle, and its velocity at this instant is the velocity of the crank-pin circle.

Bearing in mind that the circumferences of circles are to each other as their radii, and that the 7-ft. circle of the driving-wheels moved 88 ft. per second, we have the proportion $3\frac{1}{2} : 1 :: 88 : 25\frac{1}{7}$—that is, the velocity of the crank-pin circle, which is the maximum velocity of the piston, is $25\frac{1}{7}$ ft. per second with regard to the locomotive. Relatively to the earth, the piston's maximum velocity will be the velocity of the locomotive plus its own velocity in the cylinder, or $88 + 25\frac{1}{7} = 113\frac{1}{7}$ ft. per second, and its minimum velocity will be the velocity of the locomotive minus its own velocity in the cylinder, or $88 - 25\frac{1}{7} = 62\frac{6}{7}$ ft. per second, and these velocities will occur when the center line of the main rod is tangent to the crank-pin circle during the forward and backward strokes respectively of the piston.

IV.—BY J. B. LEEPER, LAFAYETTE COLLEGE, EASTON, PA.

Having noticed in your JOURNAL for April the problem given above, I was somewhat interested, and give the following as my result:

In fig. 3, let *A D E* represent the path of the crank-pin, *R* the length of crank-arm, and *l* the length of connecting-rod. The motion of the crank-pin can be resolved into two motions, one horizontal, the other vertical. Since the cross-head is fixed in the line *c x*, the vertical motion



will cause rotation of connecting-rod about the cross-head as center.

Let $v_1 =$ velocity of crank-pin.

Let $v_2 =$ velocity of cross-head due to horizontal motion of crank-pin.

Let $v_3 =$ velocity of cross-head due to vertical motion of crank-pin.

Let $v =$ velocity of crank-pin in a vertical direction.

Let the angles be represented as lettered. Then v will constantly decrease from x to y, or the acceleration will be minus and vary as the distance of crank-pin from line $c\ x$.

Let a represent acceleration

Let s represent distance from line $c\ x$.

$$a = \frac{d^2 s}{d t^2} = -b\,s, \text{ where } b \text{ is some constant}$$

$$\int \frac{d^2 s}{d t^2} d s = -b \int s\, d s$$

$$\frac{d s^2}{d t^2} = v^2 = -b\,s^2 + c_1$$

when $s = R, v = o$

$$c_1 = b\,R^2$$

$$v^2 = -b\,s^2 + b\,R^2 = b\,(R^2 - s^2)$$

$$v = b^{\frac{1}{2}}\,(1 - s^2)^{\frac{1}{2}} = b^{\frac{1}{2}} \cos.\ \theta\ (R = 1)$$

when $s = o,\ v = v_1 = b^{\frac{1}{2}}$

$$b = v_1^2$$

$$v = b^{\frac{1}{2}} \cos.\ \theta = v_1 \cos.\ \theta$$

In same way prove

$$v_2 = v_1 \sin.\ \theta$$

$v_2 + v_3 =$ velocity of cross-head.

$$v_3 = \sin.\ \beta\, v = \frac{\sin.\ \theta}{l} v_1 \cos.\ \theta$$

Let

$$u = v_2 + v_3$$

$$u = v_1 \left[\frac{\sin.\ \theta \cos.\ \theta}{l} + \sin.\ \theta\right]$$

$$\frac{d\,u}{d\,\theta} = v_1 \left[\frac{\cos.^2 \theta - \sin.^2 \theta}{l} + \cos.\ \theta\right]$$

Now, by putting this first derivative equal to o will give the maximum velocity of cross-head,

$$v_1 \left[\frac{\cos.^2 \theta - \sin.^2 \theta}{l} + \cos.\ \theta\right] = o$$

$$\cos.^2 \theta - \sin.^2 \theta + l \cos.\ \theta = o,$$

which formula will give, by substituting in it the value of l, the angle θ at which the piston has its maximum velocity.

As there is no length given for l, I take it equal to 8 ft., and find the maximum to occur when θ is equal to 83° 1′ 52″ to five decimals.

From conditions of the problem,

$$v_1 = 25.14 \text{ ft. per sec.}$$

$$\sin.\ \theta = 0.9926 \text{ ft.}$$

$$\cos.\ \theta = 0.12133 \text{ ft.}$$

Then from formula

$$u = v_1 \left[\frac{\sin.\ \theta \cos.\ \theta}{l} + \sin.\ \theta\right]$$

$$u = 25.33 \text{ ft. per sec.}$$

When piston is moving *with* train, velocity with respect to the earth will be a maximum and will equal $88 + 25.33 = 113.33$ ft. per second; also the minimum will occur when piston is moving *opposite* to motion of train, and the minimum velocity $= 88 - 25.33 = 62.67$ ft. per second.

Let

$$\theta_1 = 83^\circ\ 1'\ 52''$$

$$\beta_1 = \frac{\sin.\ \theta_1}{8}$$

Then ver. θ_1 + ver. β_1 = distance of cross-head from k in fig. 3, from which get the position of piston for maximum velocity.

THE CRUISER "CHICAGO."

THE illustration given herewith is from an excellent photograph of the cruiser *Chicago* of the United States Navy. This vessel was the first of the large cruisers of modern type built for the Navy, and is one of the best known, as she has been attached to the White Squadron as flag-ship and has visited many ports along the coast. In this service she has shown herself an excellent and ser-

viceable vessel, and her handsome proportions have been generally admired.

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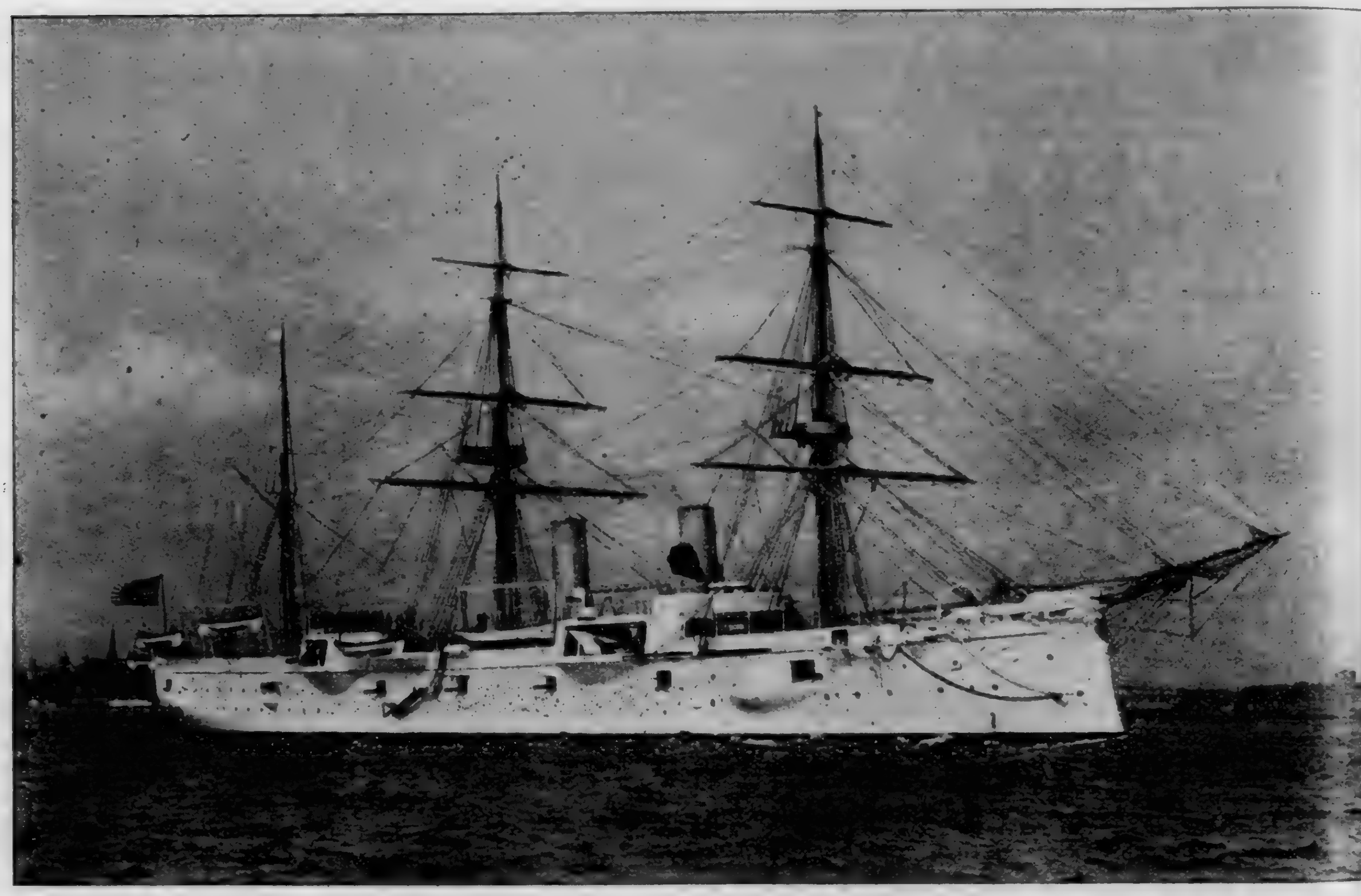

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MASTER CAR-BUILDERS' ASSOCIATION REPORTS.

THERE is given below a brief summary of the principal committee reports presented to the Master Car-Builders' Association at the Convention in Saratoga. The disposition made of these will be found in the proceedings of the Convention, on another page.

STEEL-TIRED WHEELS.

The Committee on Steel-Tired Wheels makes a brief report, stating that returns have been received from roads owning over one-third of the passenger cars in the country, and that these roads have some 25,000 steel-tired wheels in use of different patterns, the Allen, which was the earliest used, predominating. Most of the defects stated in the report relate to the tires and not to the centers, but some trouble from loose bolts is reported where bolted centers are used.

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The Committee appointed to confer with the Cast-Iron Wheel-Makers presents a resolution passed by the Wheel-Makers' Association, in relation to tests of wheels removed on account of failure, but recommends against the incorporation of this condition in the standard specifications. The only changes in these recommended are whether any allowance should be made to wheel-makers for worn flanges, with some slight changes in the wording in order to make the conditions somewhat more definite than they are at present.

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The Arbitration Committee presents a report embodying the decisions rendered during the year, and also giving a summary of the amendments to the rules proposed by the different railroad clubs, some of which are recommended for adoption and others are not. It is impossible here to give these in full, as they mostly relate to the wording of the rules, and the changes adopted appear in the report of the meeting.

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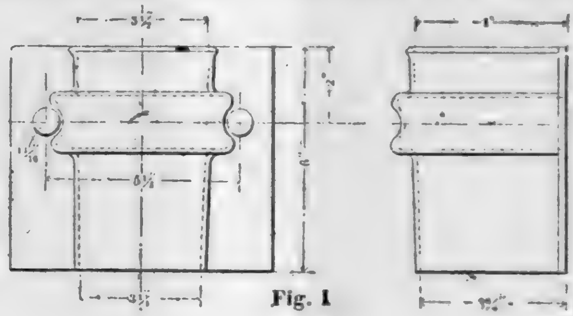

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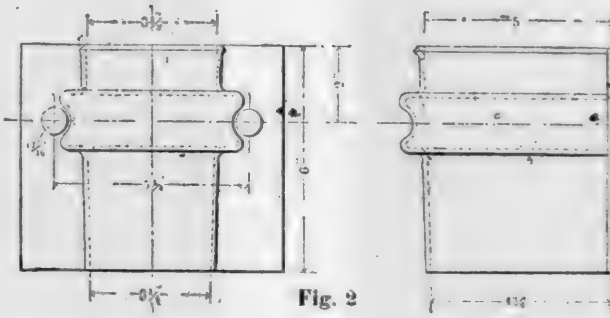

Fig. 2

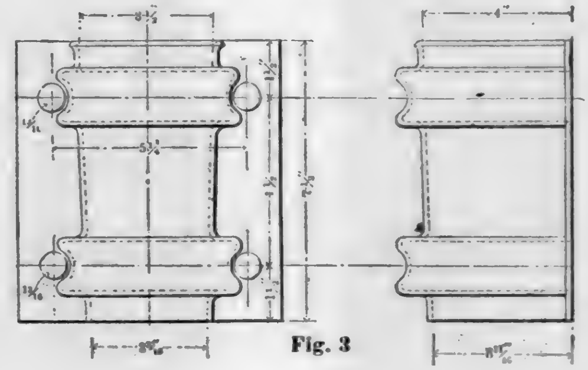

Fig. 3

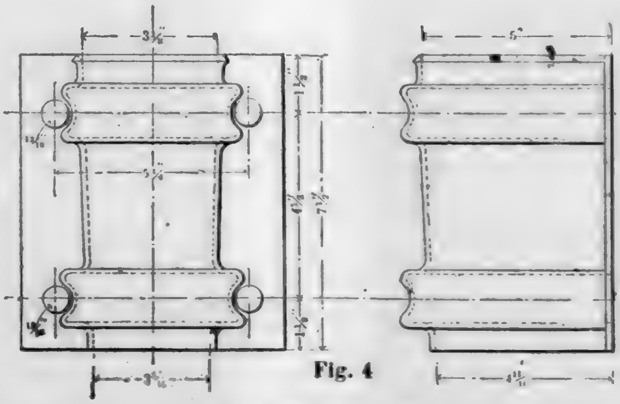

Fig. 4

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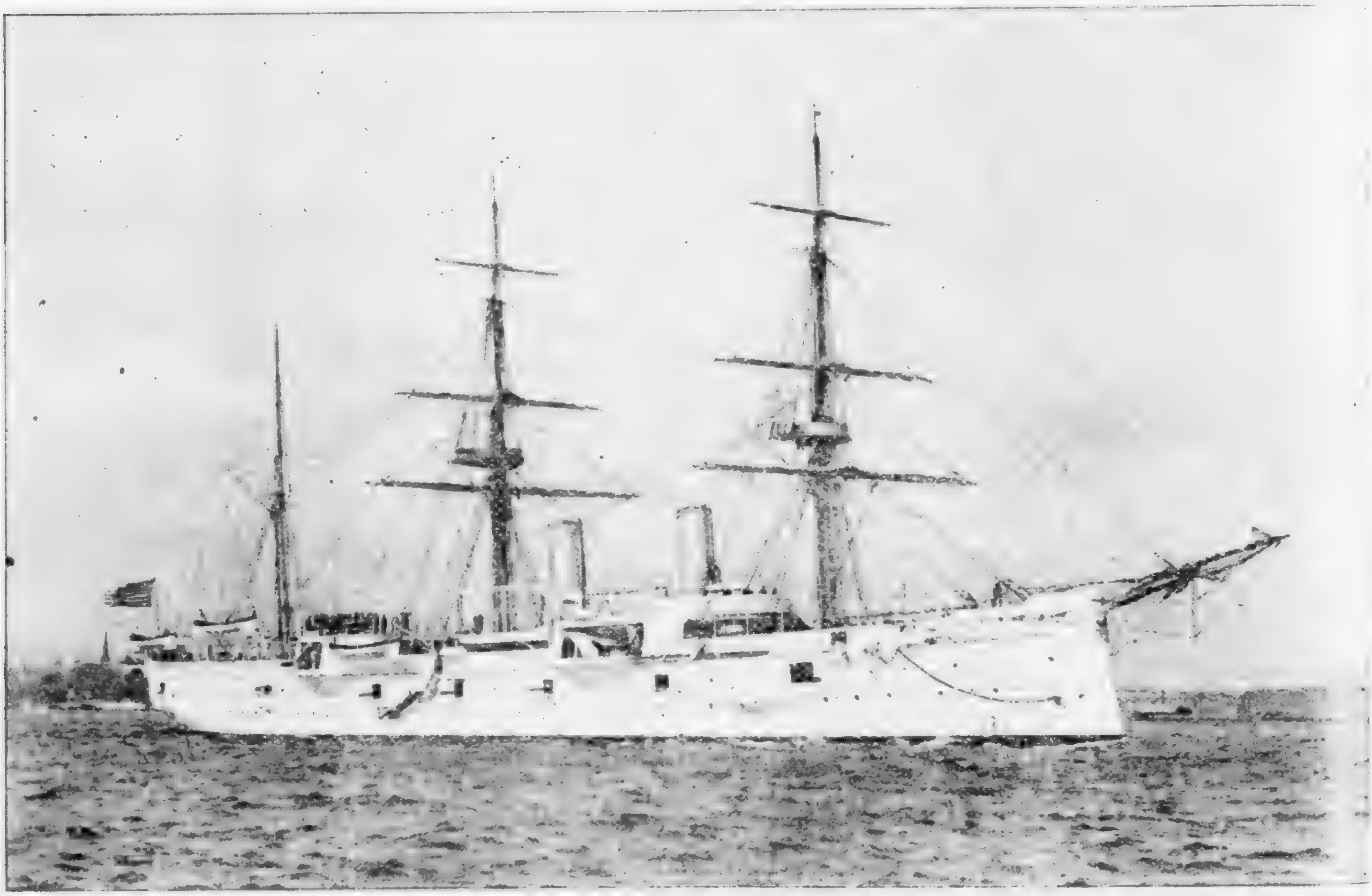

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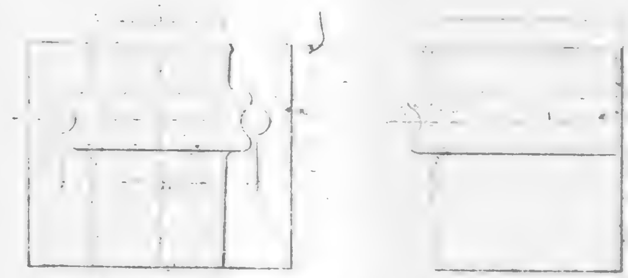


Fig. 2

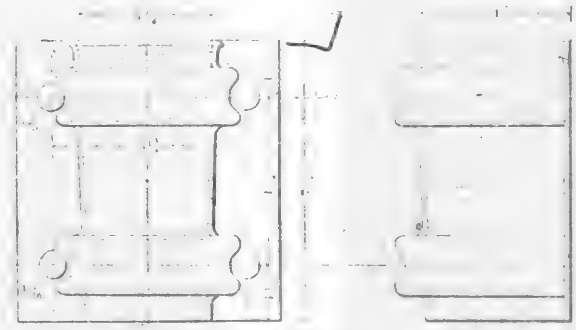


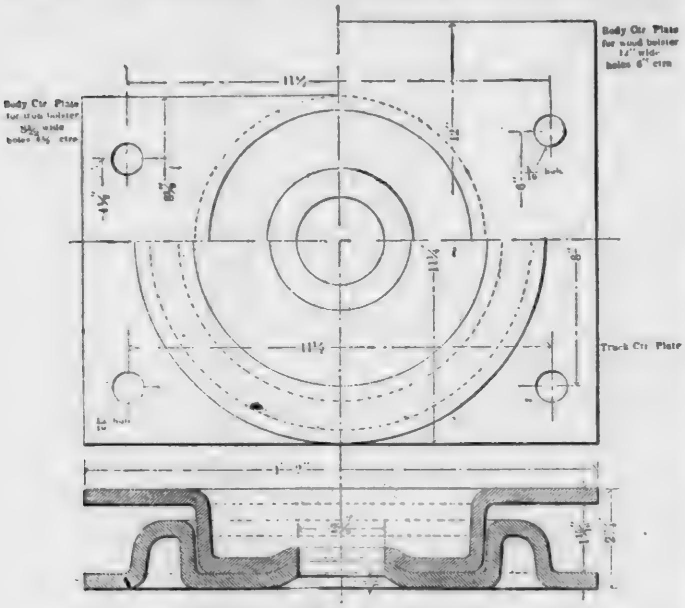
Fig. 3

Fig. 4

deep at the top and the other for stakes 5 in. at the top, the width and taper being uniform.

For center-plates fig. 5 shows the standard recommended for pressed steel. The plates are all 14 in. long, the truck center-plate being $11\frac{1}{4}$ in. wide, the body center-plate for

iron bolsters 18 in. wide and for wooden bolsters 12 in., with the holes placed as shown. There being some difference of opinion as whether the plates should have flanges to fit the bolsters, such flanges are not shown in the drawings. For malleable iron center-plates the proposed



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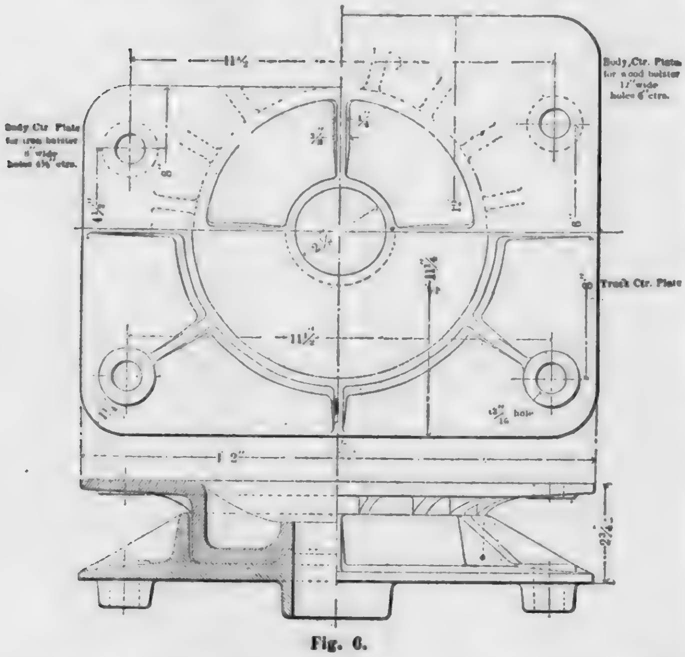


Fig. 6.

standard design is shown in fig. 6, the dimensions being there given. They are substantially the same as those for pressed steel, the only difference being in the method of construction required by the different material. The Committee appends a table giving tests of the strength of malleable iron castings, some of which show a very high elastic limit and ultimate strength.

STEAM HEATING AND VENTILATION.

This Committee reports that there has been a great increase in the number of cars heated by steam, without much change in methods. The great point required is simplicity. The report says that at the present time the various methods of heating cars by steam may be grouped into two classes, known as the direct and indirect, the distinction between the two being as follows: In the direct system steam is supplied directly to radiating pipes in the car. In the indirect system, steam is used to heat water contained in the radiating pipes in the car. The direct system is the cheaper and simpler, but it is not susceptible of as fine regulation as the indirect, although care and attention on the part of the trainmen have given very satisfactory results. The direct system also is inapplicable to cars like sleepers in which the piping is necessarily tortuous, or in cars equipped with Baker or other hot-water heaters, unless a complete additional equipment of radiating pipes is introduced. Various arrangements, some of them quite successful, have been devised for heating the water in the circulating pipes of the Baker heater by steam, leaving the heater itself intact and ready for use, in case the steam supply should fail. It is not considered advisable to make any recommendations nor express any opinion as to the relative merits or efficiency of the different systems, especially as your Committee has no reliable experimental data to present, or to form the basis of an opinion.

The immediate and most important object of this Committee is to consider the points involved in steam heating so far as they affect the matter of interchange of cars having different systems of heating or different steam connections or couplers. With this object in view, the Committee submits and recommends standards for: 1. Location and size of end of steam pipe. 2. 45° elbow for end of steam pipe. 3. Hose nipple. 4. Steam hose. 5. Location of steam coupling.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(Continued from page 273.)

Two somewhat similar experiments are alluded to in M. G. de la Landelle's "Aviation," published in 1863, but are too briefly described to give much of an idea as to the kind of apparatus employed; he says:

Paul Guidotti, an artist-painter, sculptor and architect, who was born in Lucca in 1569, constructed wings of whalebone covered with feathers, and made use of them several times with success. Determining to exhibit his discovery, he took flight from an elevation, and sustained himself pretty well in the air for a quarter of a mile, but soon becoming exhausted, he fell upon a roof, and his thigh-bone was broken. . . .

I might also cite the article from the Malaga newspaper, the *Courier of Andalusia*, which was republished in several French journals in March, 1863, stating that a peasant of the neighborhood, named *Francisco Orujo*, was said to have sailed in the air a distance of one league with artificial wings in less than fifteen minutes; but why multiply examples? It is better to deduce from these occurrences, some of which are abundantly authenticated, useful conclusions concerning the insufficiency of man's muscular power, and concerning the sustaining power of an inclined plane.

The writer has been thus far unable to find in other publications fuller accounts of the last two experiments mentioned, but it is a significant fact that the greater number of the experimenters who are said by tradition to have actually succeeded in floating for a short distance on the air, were men living in warm climates, where the soaring varieties of birds are much more numerous and more easily observed than in variable and colder climates. This suggests the inference that these experimenters had been watching the soaring birds, sailing upon fixed wings in every direction, and endeavored to imitate their evolutions. With the aid of the wind they may have attained a glimmer of success, but they failed in every instance for lack of accurate knowledge of what constitutes the science of the birds. Elsewhere than in warm climates the soaring birds are so few, they so frequently have to resort to flapping, that those who have not seen them sailing about for hours upon fixed, extended wings, deny even the possibility of such a performance, and only think of wings as oscillating surfaces; and so when, in 1842, *Henson* patented his flying machine, the proposal to obtain support from the fixed surfaces of an aeroplane was hailed by many as a new and happy idea.

A top view of *Henson's* apparatus is shown by fig. 37. It consisted of an aeroplane of canvas or oiled silk stretched upon a frame made rigid by trussing, both above and below. Under this surface a car was to be attached

containing a steam-engine, its supplies and the passengers. The apparatus was to be propelled by two rotating wheels, acting upon the air after the manner of a windmill. Back of these was a tail, also covered with canvas

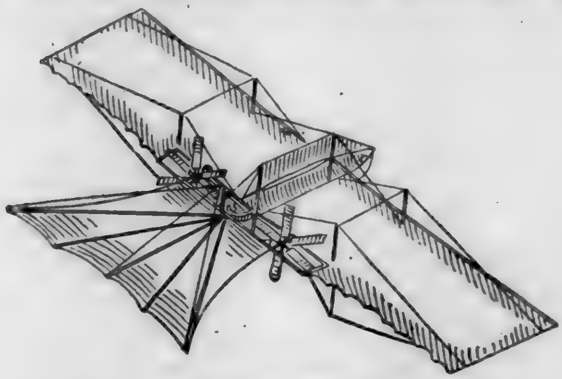


FIG. 37.—HENSON—1842.

or oiled silk, stretched upon a triangular frame, and capable of being expanded or contracted at pleasure, or moved up and down for the purpose of causing the machine to ascend or to descend. Under the tail a rudder was placed for steering the machine to the right or to the left, and above the main aeroplane a sail or keel-cloth was stretched, as shown, between the two masts which rose from the car, in order to assist in maintaining the course. The apparatus was to sail with its front edge a little raised so as to obtain the required support or lift from the air, and was to be started from the top of an inclined plane, in descending which it was to attain a velocity sufficient to sustain it in its further progress, the steam-engine being only designed to overcome the head resistance when in full flight.

Henson's patent indicates that he believed the correct proportions to be about 2 sq. ft. of supporting surface to each pound of weight, this being considerably in excess of the proportion of the large soaring birds, and that the motor required was about at the rate of 20 H.P. per ton of weight. His general design evidences careful thought and possesses some excellent features, but the form of his aeroplane was crude and its equilibrium especially was deficient. *Henson* stated in his patent:

The following are the dimensions of the machine I am making, and which will weigh about 3,000 lbs. The surface of the planes on either side of the car will measure 4,500 sq. ft., and the tail 1,500 more, with a steam-engine (high pressure) of 25 to 30 H.P.

Scaled from the patent drawings the intended dimensions of the main aeroplane appear to have been about 140 ft. long, in the direction of motion, by about 32 ft. in width, this being considerably larger than the great aeroplane that Mr. Maxim has been lately constructing in England. *Henson* did not realize his intention, for Mr. *F. W. Brearey*, Honorary Secretary of the Aeronautical Society of Great Britain, says in an article upon flying machines, published in *Popular Science Review* in 1869,* in describing the *Henson* experiments:

The fact is the machine was never constructed; for after two abortive attempts to manufacture models at the Adelaide Gallery, which should represent the dimensions before named, he rejoined his friend (*Stringfellow*) at Chard, and the two together commenced their experiments under a variety of forms. . . . However, in 1844, they commenced the construction of a model; *Henson* attending chiefly to the wood or framework and *Stringfellow* to the power, and after many trials adopted steam. This model, completed in 1845, measured 20 ft. from tip to tip of wing, by 3½ ft. wide, giving 70 square feet sustaining surface in the wings, and about 10 ft. more in the tail. The weight of the entire machine was from 25 to 28 lbs. . . . An inclined plane was constructed, down which the machine was to glide, and it was so arranged that the power should be maintained by a steam-engine, working two four-bladed propellers each 3 ft. in diameter at the rate of 300 revolutions per minute.

A tent was erected upon the downs, 2 miles from Chard, and for seven weeks the two experimenters continued their labors. Not, however, without much annoyance from intruders. In the language of Mr. *Stringfellow*: "There stood our aerial *protégé* in all her purity—too delicate, too fragile, too beautiful for this rough world; at least those were my ideas at the time, but little did I think how soon it was to be realized. I soon found, before I had time to introduce the spark, a drooping in the wings, a flagging in all the parts. In less than ten minutes the machine was saturated with wet from a deposit of dew, so that anything like a trial was impossible by night. I did not consider that we could get the silk tight and rigid enough. Indeed the framework was altogether too weak. The steam-engine was the best part. Our want of success was not for want of power or sustaining surface, but for want of proper adaptation of the means to the end of the various parts."

Many trials by day, down inclined wide rails, showed a faulty construction, and its lightness proved an obstacle to its successfully contending with the ground currents.

The above has been given verbatim, because of the importance of the experiments. Stated in plainer terms, it means that the machine was deficient in stable equilibrium for out-of-door experiments; that "ground currents" or little puffs of wind would destroy the balance, and that in falling to the ground it would get more or less injured. That the experimenters, annoyed at the presence of spectators at these mishaps, endeavored to test their machine at night, with still less success, and finally gave it up in disgust. Mr. *Brearey* then continues:

Shortly after this *Henson* left England for America, and Mr. *Stringfellow*, far from discouraged, renewed his experiments alone. In 1846 he commenced a smaller model for indoor trial, and, although very imperfect, it was the most successful of his attempts (an illustration from a photograph is given); the sustaining planes were much like the wings of a bird. They were 10 ft. from tip to tip, feathered at the back edge, and curved a little on the under side. The plane was 2 ft. across at the widest part; sustaining surface, 17 sq. ft.; and the propellers were 16 in. in diameter, with four blades occupying three-quarters of the area of the circumference, set at an angle of 60°. The cylinder of the steam-engine was ¾ in. diameter; length of stroke, 2 in.; bevel gear on crank-shaft, giving 3 revolutions of the propeller to 1 of the engine. The weight of the entire model and engine was 6 lbs., and with water and fuel it did not exceed 6½ lbs.

The room which he had available for the experiments did not measure above 22 yds. in length, and was rather contracted in height, so that he was obliged to keep his starting wires very low. He found, however, upon putting his engine in motion that in one-third the length of its run upon the extended wire, the machine was enabled to sustain itself; and upon reaching the point of self-detachment it gradually rose until it reached the farther end of the room, where there was a canvas fixed to receive it. Frequently during these experiments it rose after leaving the wire as much as 1 in 7.

Stringfellow then went to Cremorne Gardens with the two models, but found the accommodations no better than at home. It was found that the larger model (*Henson's*) would run well upon the wire, but failed to support itself when liberated. Owing to unfulfilled engagements as to room, Mr. *Stringfellow* was preparing for departure, when a party of gentlemen, unconnected with the gardens, begged to see an experiment, and finding them able to appreciate his endeavors, he got up steam pretty high and started the small model down the wire. When it arrived at the spot where it should leave the wire, it appeared to meet with some little obstruction and threatened to come to the ground, but it soon recovered itself and darted off in as fair a flight as it was possible to make, to a distance of about 40 yds., farther than which it could not proceed.

Having now *demonstrated the practicability of making a steam-engine fly*, and finding nothing but a pecuniary loss and little honor, this experimenter rested for a long time satisfied with what he had effected.

It is evident that, taught by experience, Mr. *Stringfellow* had obtained greater stability in the smaller model. The aeroplane was shaped like the wings of a bird, slightly curved on the underside and feathered at the back edge, so that the elastic yielding of the feathers might automatically regulate the fore and aft stability, like the back fold in the paper aeroplane which has been described; but the equilibrium was still insufficient for experiment out-of-doors, and the important problem of safely coming down was not solved at all, for to prevent

* *Popular Science Review*, vol. 8, p. 1.

breakage the apparatus had to be caught in a canvas fixed to receive it.

The sparrow-hawk, whose excursion has been described (fig. 36), solved this last problem by simply tilting himself back and opening his wings wide so as to stop his headway by increased air resistance. This possibly might be done with a full-sized apparatus mounted by an operator, but was scarcely practicable in a small model. To mitigate this difficulty Mr. *Stringfellow* increased the sustaining surface, so that it was 2.61 sq. ft. per pound, and therefore might act like a parachute, but this largely increased the "drift," and required more power, so that water and fuel could only be provided for a very brief flight, and the machine cannot fairly be said to have "demonstrated the practicability of making a steam-engine fly."

Mr. *Stringfellow* took the matter up again in 1868, and made further experiments with a somewhat different apparatus, which will be described in due course.

The next proposal for an aeroplane was that of *Aubaud*, in 1851, which is shown in fig. 38. It provided for a number of supporting planes, above which rotating screws were to furnish ascending power, while vibrating wings

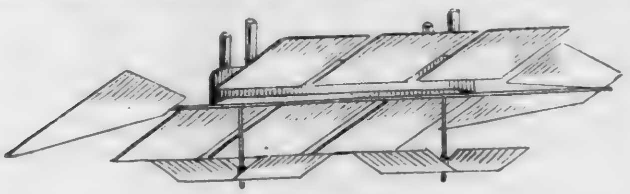


FIG. 38.—AUBAUD—1851.

were to propel. The car containing the motor was to be beneath the planes, and equipped with legs or tubes containing compressed air, in order to ease off the shocks which might be encountered in alighting.

M. *Aubaud* seems to have reasoned that in order to secure safety in coming down, it was necessary to arrange matters so that the whole weight, or nearly the whole weight of the apparatus, could be sustained by screws when about alighting. This same general idea will be found to crop out in a number of subsequent proposals by inventors, who have believed that in order to come down safely it is necessary to design a machine which has enough power to start up by itself on level ground. This, of course, requires much more power than if only horizontal flight is provided for, and handicaps the inventor in an experimental machine.

The writer has been unable to ascertain whether *Aubaud* ever tested his apparatus experimentally. It seems clear that if he did, he must have become aware that no motor then known was sufficiently light in proportion to its energy to raise his machine into the air with screws, especially as he actually increased the ascending resistance by placing planes beneath the screws, so that the latter would not only have to sustain the weight, but also

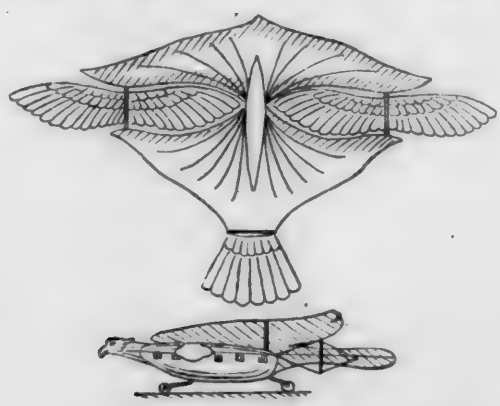


FIG. 39.—LOUP—1852.

to overcome the vertical air pressure resulting from the movement. He advanced a meritorious proposal, however, by dividing the sustaining surface into several planes, an arrangement which we shall find (in describing Mr. *D. S. Brown's* experiments) to add materially to the stability; but even with this feature the apparatus, as shown in the figure, is deficient in equilibrium, and would have come to grief many times if it had been experimented with.

The succeeding year *Michel Loup* proposed another form of aeroplane, which is shown both in plan and in side elevation in fig. 39. It is described both by M. *Dieuaide* and M. *Tissandier* as consisting of a supporting plane propelled by four rotating wings, and provided with a rudder, also with legs beneath the car carrying wheels upon which the machine might roll upon alighting on the ground, an arrangement subsequently proposed again by many inventors.

The writer has been unable to find any record of experiments tried with this apparatus (which is chiefly here figured to show the wheeled feet), and it seems difficult to conceive of its successful operation.

In 1856 *Viscount Carlingford* patented both in England and France the aeroplane shown in fig. 40, and resembling in outline a falcon gliding downward with partially

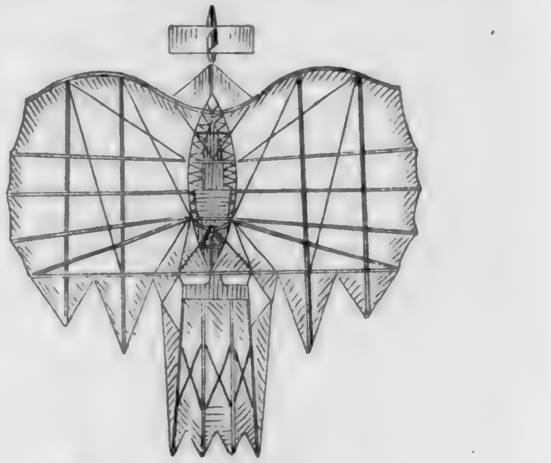


FIG. 40.—CARLINGFORD—1856.

closed wings. In the center was a car or chariot, described by the inventor as follows:

> The aerial chariot in form is something in the shape of a boat, extremely light, with one wheel in front and two behind, having two wings, slightly concave, fixed to its sides, and sustained by laths of a half hollow form pressing against them, and communicating their pressure through the body of the chariot from one wing to the other, and supported by cords, whose force, acting on two hoops nearly of an oval shape, hold the wings firmly in their position.

A tail can be raised and lowered at pleasure by means of a cord.

The chariot is drawn forward by an "aerial screw" in front thereof, "which screws into the air at an elevation of 45°, similar to the bird's wing; and is turned by means of a winch acting on three multiplying wheels." This screw "is known as the Carlingford screw; the blades of this screw become more straight as they approach the center, or, in other words, their edges become more direct toward the center. . . . When a certain altitude is attained the chariot may go several miles, perhaps 50 or 60, as it were, upon an inclined plane of air."

A novelty consisted in the mode proposed for starting the chariot. It was proposed to suspend it by ropes between two poles, and then allow it (by drawing a trigger suddenly) to fall upon the air and to be drawn "forward with great velocity by the falling of the weight in front;" a method which we have seen to have been subsequently adopted by M. *Trouvé* in starting his bird. If the inventor was thoroughly assured beforehand of the stability of his apparatus at all angles of incidence, this would be an elegant method of getting under way, but it would be somewhat awkward if there was any miscalculation about the position of the center of pressure. The writer has found no record of any experiments with the Carlingford apparatus.

(TO BE CONTINUED.)

AN ENGLISH LOCOMOTIVE FOR MIXED TRAFFIC.

THE accompanying illustration, from London *Engineering*, shows a class of locomotives designed by Mr. James Holden, Locomotive Superintendent of the Great Eastern Railway of England; they are used on that road for running the heavy excursion traffic to the seaside resorts in the summer, while in the winter they are used on the market, stock and fast freight trains. About 30 of this class are in use, and 30 more have lately been ordered. The general design, as will be seen, is an inside-connected engine with four coupled drivers and a single pair of leading wheels in front.

LOCOMOTIVE FOR MIXED TRAFFIC, GREAT EASTERN RAILWAY, ENGLAND.

The boiler is 52 in. in diameter and has 252 tubes, 1⅝ in. diameter and 10 ft. 4 in. long. The inside fire-box is of copper; it is 63⅞ × 40½ in., and varies in depth from 61½ to 67½ in. The grate area is 18 sq. ft.; the heating surface is: Fire-box, 101; tubes, 1,107; total, 1,208 sq. ft. The smoke-stack has a sectional area of 1.06 sq. ft., the ratio to the grate area being 1 : 16.8.

The main frames are of 1-in. steel plate; the outside frames at the leading end are ⅞ in. thick, welded just forward of the driving axle to a 6 × 3 × ½-in. angle iron, which carries the running board.

The leading wheels are 48 in. in diameter. The leading axle has both outside and inside journals, the former 6 in. and the latter 8¾ in. in diameter. The inside journals carry most of the weight. A lateral play of 1 in. is given to the journal boxes, to permit the engine to pass freely around curves.

The cylinders are 17½ in. in diameter by 24 in. stroke. The steam ports are 15 × 1½ in. and the exhaust ports 15 × 3¼ in. The valve is of the shifting link type. The valves have ⅞ in. outside lap, and their maximum travel is 3¾ in. The two cylinders are cast in one piece and have the steam chests below. They are set on an incline of 1 in 8, but the valve faces are horizontal. The crossheads work on single-bar guides. The engine has Macallan's variable exhaust nozzle.

The driving-wheels are 68 in. in diameter. The driving-axles have 7½ × 9-in. journals. The driving-wheel-base is 8 ft. 9 in., and the total wheel-base is 16 ft. 6 in.

The tender is of the usual English type and is carried on six wheels, with outside bearings and a plate frame.

It may be mentioned that cast steel has been used wherever possible in these engines. They are fitted with the Westinghouse brake.

The total weight of the engine in working order is 90,300 lbs., of which 58,600 lbs. are carried on the leading wheels and 31,700 lbs. on the four coupled driving-wheels.

These engines, which are of a type much approved in England for heavy suburban or excursion traffic, might be compared with the Reading suburban engine given on another page.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

BY A. ZDZIARSKI, C.E.

(*Continued from page 260.*)

IN the first part of this article, in the June number of the JOURNAL, a map showing the location of the road was given; in the present number we give a sketch map of Western Siberia, showing the relative position of the road.

The small diagram shows the profile of the Zlatooust-Chelabinsk Railroad, which really forms the first section of the line, and which extends the Samara-Oufa-Zlatooust line—the connection of the Siberian road with European Russia—to the town of Chelabinsk on the eastern side of the Oural Mountains. This road is now nearly completed, and the starting point for the Western Siberian Railroad will be at Chelabinsk.

The large diagram is a profile of the Western Siberian Railroad as located. It shows first the descent of the eastern slope of the Ourals; then the long level section across the great plateau of Western Siberia, where the only considerable variations from a level are at the crossings of the great rivers—the Tobol, the Ishim and the Irtish—and finally the rise from this plateau into the mountainous region west of Lake Baikal, where the junction with the previously surveyed portion of the Central Siberian line begins.

Since the first part of this article was received, the Committee of Ministers having the matter in charge has decided—April 28/May 10—on the following points:

1. The road is to be built on the location of 1891, which

is shown in our maps and described in the accompanying text, starting from Chelabinsk and passing through Kourhan, Petropavlosk, Omsk, Kainsk, Kolyvan and Pochitanka.

2. The construction of the first section—from Chelabinsk to Omsk—is to be begun during the present year.

3. The road is to be built by the Government directly; for 1892, however, a credit of only 1,100,000 roubles has been granted for the work.

PRINCIPAL FEATURES OF THE LOCATION.

The design of the Western Siberian Railroad, executed according to the relaxations permitted in the specifications, presents the following principal features:

The grade is designed for single track only; the gauge is fixed at the Russian standard of 5 ft.

The ruling gradient for the First Division from Chelabinsk to the Obi River is fixed at 0.6 per cent., and for the Second Division from the Obi River to the connection with Central Siberian Railroad at 0.8 per cent. The minimum radius of curvature is placed at 1,750 ft., and in exceptional cases at 1,400 ft. The total length of level grades is about 500 miles, or 56.5 per cent. of the whole. The percentage of gradients in the direction from Chelabinsk to the Obi River is as follows: Less than 0 5 per cent., 13 per cent. of the whole; and from 0 5 to 0.6 per cent., only 6 per cent. The percentage of curved line is 6.48 per cent., including 0 08 per cent. of curves of a radius of 1,400 ft.

The grade, for single track only, is designed to be 16.45 ft. wide in all cuttings, and in small embankments under 8¾ ft. high, and 18 2 ft. wide on higher embankments subject to shrinkage, and in embankments on marshy ground. The slopes of cuttings are designed to be 1½, those of embankment 1½, and this could be varied according to the kind of earth. Near the river crossings the grade is designed to be 3½ ft. above high water, and 5 ft. for the great rivers.

The earthwork on the First Division, between Chelabinsk and the Obi River, on 833 miles, consists almost exclusively of small embankments (3 to 4 ft.), and the total estimated quantity is 26,746,000 cubic yards, or about 30,000 cub. yds. per mile. Heavy embankments occur only at the crossings of the rivers Tobol, Ishim, Irtish, Chik and Obi. At the latter there are 380,000 cub. yds. per mile. For the execution of the earthworks it is designed to apply an American machine, the Austin New Era Grader.

A distinguishing feature of the Western Siberian Railroad is an absence of small river crossings required. The line crosses the great rivers Tobol, Ishim, Irtish, Obi and Tomi, but in the intervals between these great rivers there are no secondary thalwegs or valleys, and the soil presents only small local depressions without any well-pronounced slope and watershed.

The great Siberian rivers have this common feature, that they run from south to north, and therefore the ice clears out or breaks up in the upper parts earlier, giving them for a time a great quantity of water.

The time of clearing and freezing of these rivers is the following:

	Time of Clearing.	Time of Freezing.
Tobol at Kurhan....	April 7/19 — 18/30	Oct. 11/23 — Nov. 9/21
Ishim at Petropavlovsk....	April 3/15 — 21/May 3	Oct. 11/23 — Nov. 8/20
Irtish at Omsk	April 11/23 — 29/May 11	Oct. 11/23 — Nov. 13/25

The spring high waters run in the Tobol about two weeks, in the Ishim also about the same, and rise to 20 and 28 ft.; in the Irtish they last very long—from May to the end of July—rising to 20 and 25 ft. The Tobol and the Irtish are navigable; the Ishim is not, and in summer runs in a very small bed, about 200 ft. wide.

The bridges of small spans from 7 ft. to 140 ft. are designed to be of wood; the spans of 7 and 14 ft. will be very like the American trestle bridge; the great wooden bridges are designed to be of the Howe truss system.

The great bridges are designed to be of iron, with spans covered by semiparabolic trusses, resembling the Linville system, 350 ft. long.

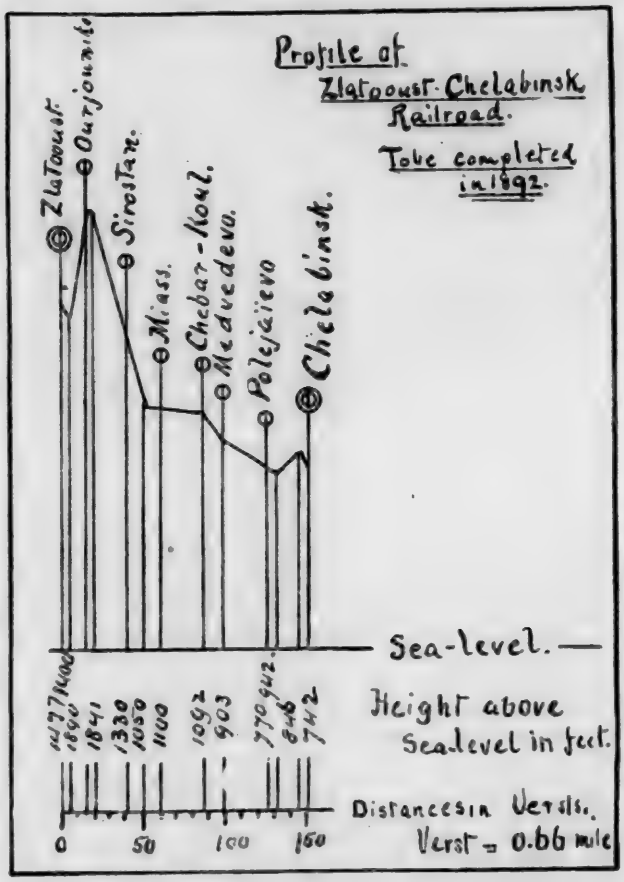
These great iron bridges are designed only over the Tobol (1,400 ft. clear length), over the Ishim (700 ft. clear length), and over the Tomi River.

Besides these on the division between Chelabinsk and the Obi River there are designed one wooden bridge of 140 ft. span over the Chik River; 335 small wooden bridges of spans from 14 to 105 ft.; three stone culverts of 7 ft. span, one culvert of 10½ ft. span, and 10 cast-iron pipe culverts of 3½ ft. diameter.

On the other or eastern side of the Obi River the spans at a number of small rivers are not yet fixed.

The Irtish and the Obi rivers, requiring bridges of 2,100 and 2,800 ft. clear length, will be provisionally crossed by steam ferries.

As noted above, the thickness of ballast is to be 12½ in., which requires about 2,850 cub. yds. per mile; the ties will be 8 ft. in length, and their number is about 2,325 per mile. The total length of sidings will be 10 per cent.

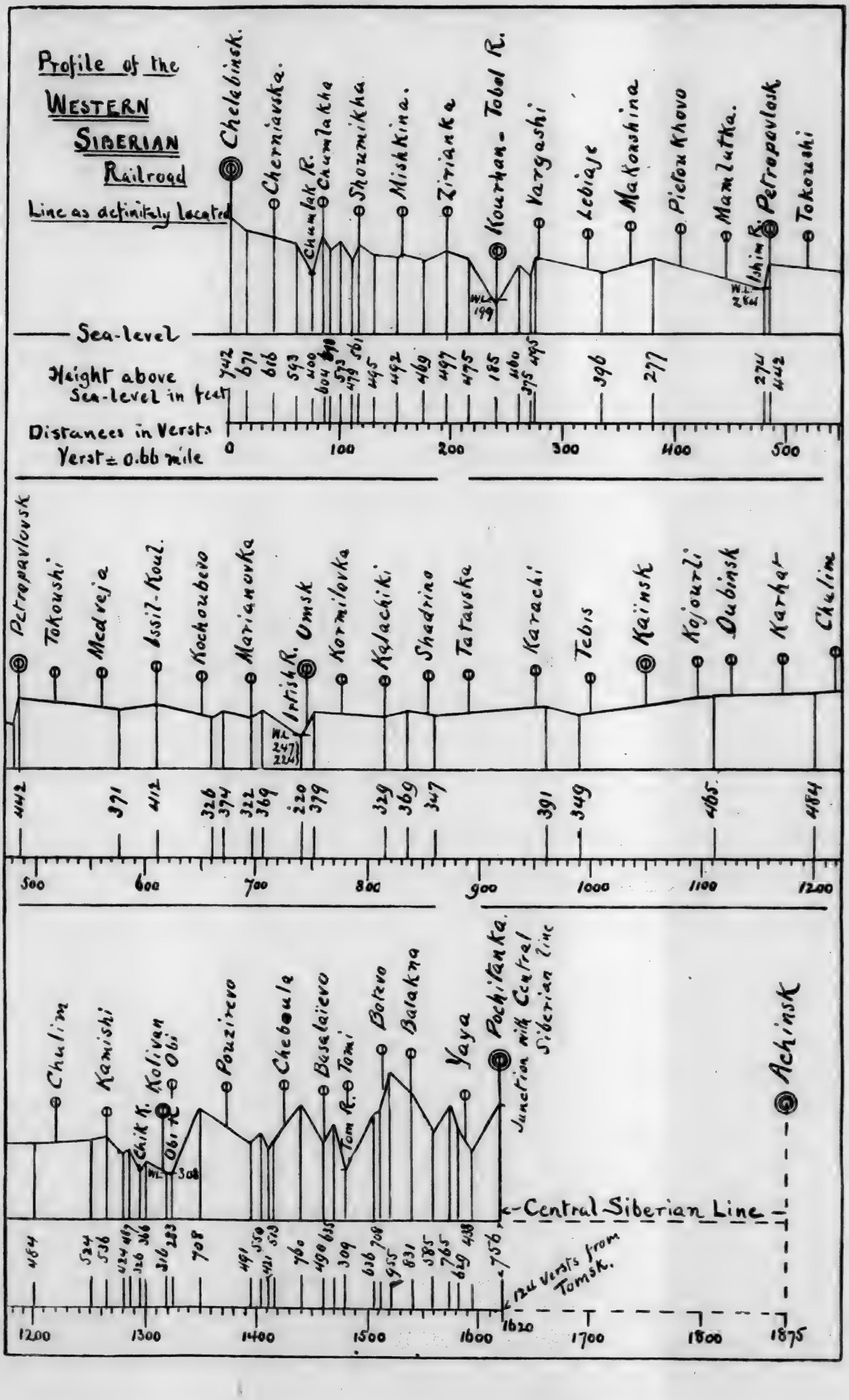


of the main track. The rails are somewhat light—54 lbs. Russian or 49 lbs. English to the yard—but this weight was fixed for the sake of economy.

For the roadmasters, road-workmen and the track watchmen there will be section-houses, great and small, and watchmen's houses. All these buildings will be constructed of brick or wood, according to the facility of getting materials. The distance between large section-houses is fixed at 12 miles; this interval is divided by small section-houses and watchmen's houses, so that the road section will be 4 miles and the watchman's beat 2 to 3 miles.

For the division between Chelabinsk and the Obi there will be required 82 large section-houses, 150 small section-houses and 184 watchmen's houses. There will be 397 road crossings.

There will be in all 33 stations built on the type generally adopted on the State railroads, two—Chelabinsk and Omsk—being rated as of the second class; four of the third class, at division points; five as of the fourth class and 21 of the fifth class. The greatest distance between stations is 33 miles. In the middle between the most dis-


Profile of the
Western
Siberian
Railroad
Line as definitely located
Sea-level
Height above Sea-level in feet
Distances in Versts
Verst = 0.66 mile
Chelabinsk.
Cherniavska.
Chumlak R.
Chumlakha
Shoumikha
Mishkina.
Zirianka
Kourhan- Tobol R.
Vargashi
Lebiaje
Makoushina
Pietoukhovo
Mamlutka.
Ishim R.
Petropavlosk
Tokoushi
Petropavlovsk
Tokoushi
Medreja
Issil-Koul.
Kochoubevo
Marianovka
Irtish R.
Omsk
Kormilovka
Kalachiki
Shadrino
Tatavska
Karachi
Tebis
Kainsk
Kojourli
Oubinsk
Karhat
Chulim
Chulim
Kamishi
Chik R.
Kolivan
Obi R.
Obi
Pouzirevo
Cheboula
Besalaievo
Tom R.
Tomi
Botevo
Balakna
Yaya
Pochitanka.
Junction with Central Siberian line
Achinsk
Central-Siberian Line
1326 Versts from Tomsk.

tant stations will be so-called half-stations, consisting of a section-house with telegraph-room, but having no sidings ; the latter will be put in as the traffic increases sufficiently to require it.

The second-class station passenger buildings will be of brick with sheet-iron roof. The third and fourth-class station buildings can be of wood or brick with iron roofs. The fifth-class stations will have no passenger-house, only a passenger-room in the house for employés.

As the country is very thinly settled or populated, the Government must provide lodgings for all the officers and employés. For this purpose there will be constructed houses of various sizes of wood or brick on masonry foundations, with sheet-iron roofs, at a rate of about 845 sq. yds. per mile.

There will be 11 engine-houses of quadrangular form for 4, 9 or 12 engines, and it is calculated that 70 per cent. of the engines will be in the engine-houses at one time. The greatest distance between the engine-houses will be 100 miles. These engine-houses will be of masonry with sheet-iron roofs.

The repair shops will be only in Omsk and on a small scale. They will be also of masonry with sheet-iron roof.

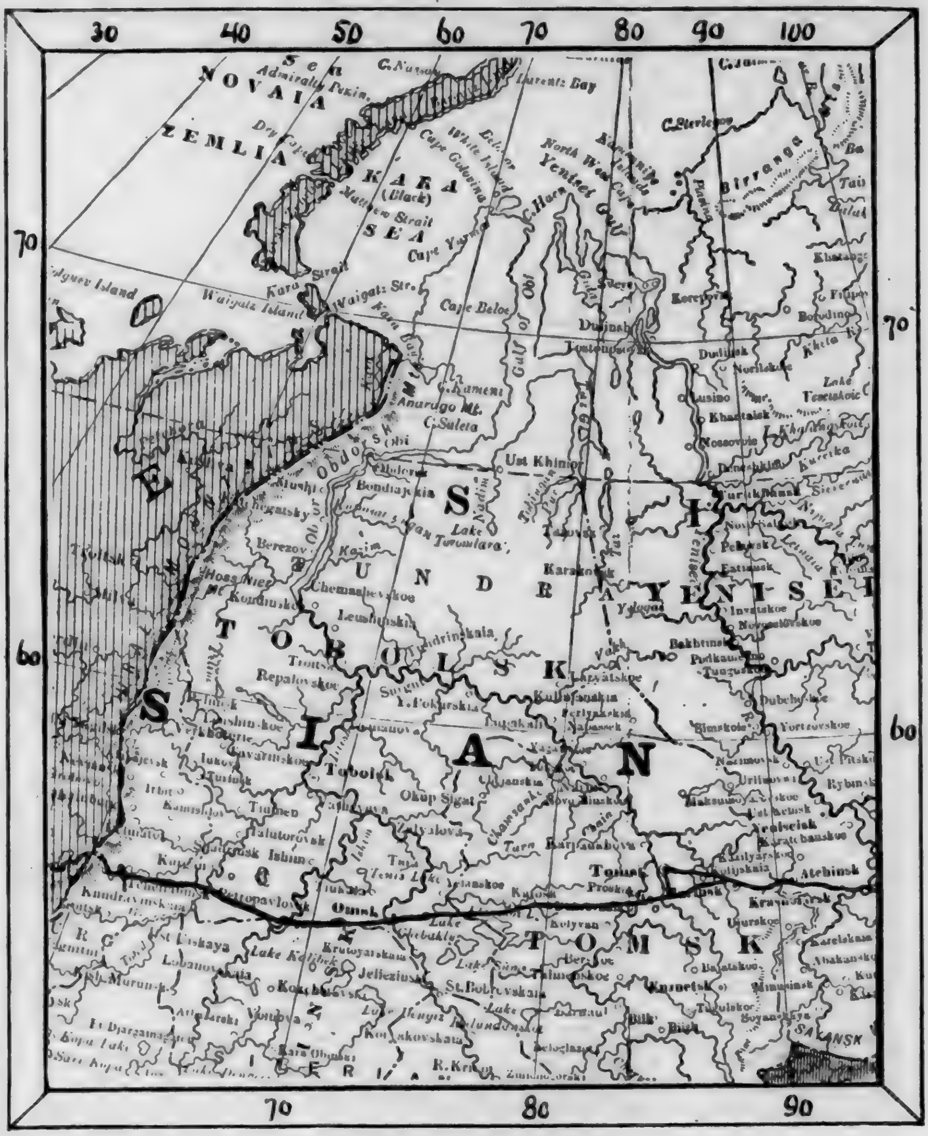
As the water-supply is very important for the traffic capacity of the railroad, it is therefore designed on the supposition of 7 trains daily in each direction. The quantity of water is calculated at the rate of about 16 cub. ft. per train mile. It was not easy to find suitable sources, because the rivers are not numerous, many lakes have bitter-salt water, and the marshy lakes are very shallow and the water freezes in winter to the bottom. Besides this the country becomes every year more dry. The greatest difficulties occur on the section between the rivers Ishim and Irtish, where there are no rivers or springs, and the water-supply will be provided by means of artificial reservoirs, which are very expensive. There are suggestions to apply the artesian wells, and for that purpose a geological inquiry by borings has been commenced.

As the greatest distance between stations (sidings) is 33 miles, and the mean speed of passenger trains will be 17 miles an hour and of freight trains 12 miles an hour, the traffic capacity of the line and sidings answers to running four trains daily in each direction—one mixed and three freight trains. If additional sidings be put between the stations, reducing the distance between them to 18 miles, then the line will permit the running of seven trains daily in each direction.

The supply of rolling stock is supposed to be sufficient for one mixed and one freight train daily in each direction. According to this the division from Chelabinsk to the Obi will require 120 locomotives, and the division from Obi to Achinsk, on the Central Siberian Railroad, 67 locomotives.

The stations will be fully equipped with signals and switches, and for this purpose there will be used 343 switches, 75 switch-houses, and 64 semaphores. There will be 10 turn-tables of the Sellers pattern, 55 ft. in diameter, and 2 weigh-platforms. The station yards will be partly paved and provided with fences.

The approximate estimated cost of the Western Siberian Railroad is given in the following table :



WESTERN SIBERIA.

SHOWING LOCATED LINE OF SIBERIAN RAILROAD.

	Length in miles.	Cost in Roubles.	
		Total.	per mile.
I. From Chelabinsk to Omsk with Irtish Bridge and branch......	498	26,300,000	52,820
II. From Omsk to the Obi River...	387	16,000,000	41,340
Total	885	42,300,000	47,800
III. From the Obi River to Pochitanka on Central Siberian Railroad.	202	16,400,000	81,180
IV. From Pochitanka to Achinsk (a part of Central Siberian line)..	170	8,750,000	51,470
V. Branch to Tomsk..............	53	2,370,000	44,700
Total....	425	27,520,000	64,900
General Total............	1,310	69,820,000	53,300

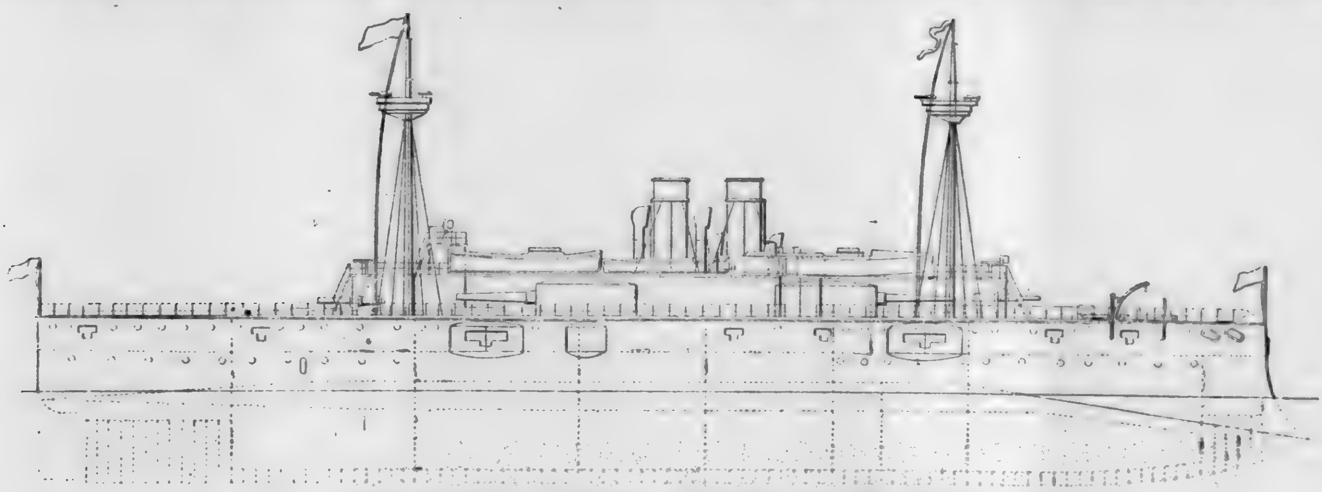
It is supposed that the final location will reduce the cost of Sections III, IV and V about 10 per cent., and that the cost per mile will be 51,760 roubles, including the rails and rolling stock, which amount to 18,215 roubles per mile. The total estimated expenditure is thus nearly $42,000,000, or about $31,980 per mile.

When we remember that this statement covers less than one-third of the work, the magnitude of the Great Siberian Line will be appreciated.

THE UNITED STATES NAVY.

As has been before stated, the next ship to be launched will be the *Texas* at the Norfolk Navy Yard, which will probably be put in the water July 1. The engines of this ship are now well advanced toward completion at the Richmond Locomotive Works, although the work on the boilers was somewhat delayed by a fire in the boiler shop, and they will be ready as soon as the ship is prepared to receive them. The launch of the *Texas* will soon be followed by that of the *Cincinnati* at the New York Navy Yard and by Cruisers 11 and 12. Of the smaller vessels, the *Detroit* will be ready for trial in August and the *Montgomery* in October, while the *Castine*, the *Machias* and the *Bancroft* will all three be ready for trial during the summer. The harbor-defense ram at the Bath Iron Works is also nearly ready for launching.

The accompanying sketch is from a drawing of the original design for the *Texas*.



BATTLE-SHIP "TEXAS," UNITED STATES NAVY.

ORDNANCE NOTES.

The Bethlehem Iron Company is to furnish the forgings for a gun of nickel steel. The gun is to be of 8-in. caliber, and the forgings will be of the same dimensions as those of the type 8-in. gun, the only difference being that the steel will be alloyed with 3 per cent. of nickel. The conditions of the contract prescribe an increase of about 15 per cent. over the limits made for ordinary steel forgings.

The Builders' Iron Foundry, of Providence, R. I., has finished the last of the 30 new 12-in. breech-loading rifled mortars, the work being completed several weeks in advance of the time required by the contract.

THE ERICSSON SUBMARINE GUN.

The trials made with the submarine gun of the *Destroyer* at the New York Navy Yard have shown some interesting results. The gun was fired a number of times at different depths under water, and while there was some disappointment as far as accuracy of direction was shown, a record of 10 shots shows that all of them would have hit a ship drawing 22 ft. below the water-line at a range of 100 ft. Nine of these would have been effective on the same vessel below the water-line at 200 ft.; four at 300 ft.; three at 400 ft., and two at 500 ft. The official report has not yet been published, but it may be said that the tendency of the projectiles to rise to the surface was somewhat less than had been expected, and the main difficulty found was in accuracy of direction. Some further trials are still in progress.

ARMOR TESTS.

The acceptance test of the diagonal armor for the battleships *Indiana* and *Massachusetts* took place at the Indian Head Proving Grounds, May 21. The results were entirely satisfactory, and most gratifying to the Naval officials, as they show that armor-plate manufactured in this country is beyond the experimental stage, and that we may now expect the construction of armored vessels to proceed without further delay. The plate tested was one of twenty 14-in. diagonal nickel steel plates manufactured by the Bethlehem Iron Company for the battle ships *Indiana* and *Massachusetts*, being the thickest armor-plates yet made in this country. The plate more than complied with contract requirements. None of the three shots fired succeeded in getting far enough into the plate to show the backing. All three shots rebounded, one of them back to the muzzle of the gun, a distance of 135 ft. The deepest penetration of any of the projectiles was 14 in. The other two showed an inch or two less. No cracks were developed. A 10-in. gun was used in the test. Two of the projectiles were the Firth, imported, and the third was made by the same process in this country. The latter was thrown out entirely uninjured. The projectiles weighed 500 lbs. and the powder charge used was 140 lbs., giving a striking velocity of 1,410 ft. a second.

A PROCESS FOR PRESERVING WOOD.

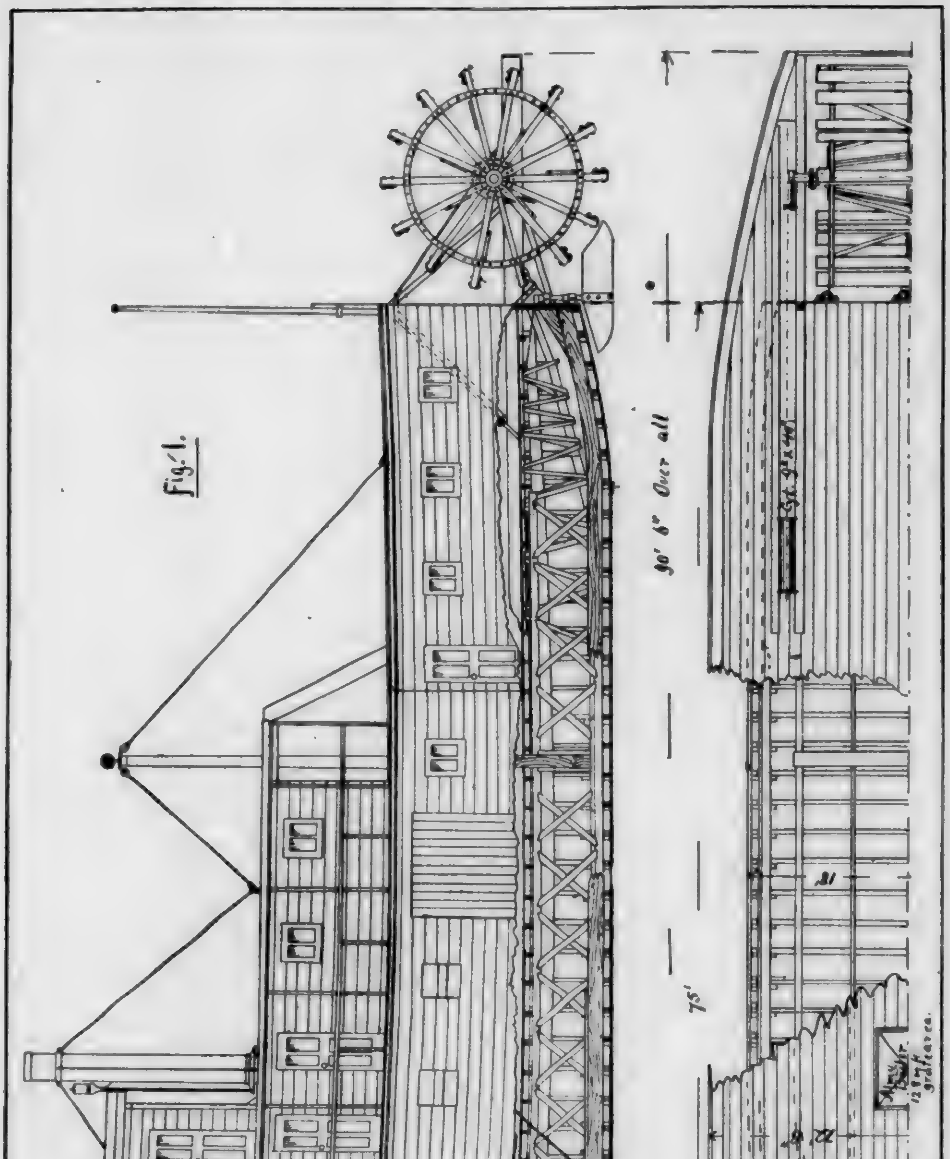
For some years past the Creosote Lumber & Construction Company have had in operation at Fernandina, Fla., works for treating lumber with a view of preserving it against the action of the weather and of water, which have attained a considerable degree of success. The nature of the preservative used is explained below. The process may be described as follows:

All timber is carefully measured and its cubic contents computed, of which an accurate record is kept in the office; it is then loaded on iron trucks and run into one of the creosoting cylinders. The doors of the creosoting cylinder are hermetically closed and the timber steamed; this is done by admitting live steam directly in the cylinder and by passing super-heated steam through pipes placed for that purpose in the cylinder. During the steaming process the pores of the timber are opened, the fibers softened, moisture and sap evaporated, and the albumen coagulated. The duration of the process depends upon the seasoning of the timber and the amount of oil to be injected; it is generally from 10 to 12 hours. Then the live steam is shut off and the vacuum pump is set to work, which withdraws the evaporated moisture and sap and discharges the same in condensed form. The duration of this process is about six hours; during this time a vacuum of from 20 to 25 in. is produced in the cylinder.

Now the charge is ready for the oil.

All the oil used for one charge is taken out of the working tank and is previously heated to about 175°. The working tank is a square iron tank 25 ft. wide, 40 ft. long and 4 ft. deep; each vertical inch or inch of depth represents 620 United States gallons.

To compute the amount of oil required for a charge the following calculation is always made; the cubic contents



of each creosoting cylinder are known, also the contents of the charge, being previously measured and computed. By subtracting the cubic contents of the charge from the cubic contents of the cylinder, the difference represents the vacant space in the cylinder—this amount can be readily expressed in gallons—the amount of oil to be injected per cubic foot of charge is known and can also be expressed in gallons, consequently the whole amount of oil to be taken from the working tank to fill the vacant space in the cylinder and to go in the timber is known in gallons.

A float with an indicator rests upon the oil in the working tank; the position of the indicator is marked on a gauge-board secured to the covering of the working tank just before the oil is allowed to flow into the creosoting cylinder. Then the valves in the pipes connecting the working tank with each creosoting cylinder are opened and the hot oil is drawn into the cylinder by means of the vacuum. As every inch of depth of oil in the working tank represents 620 gallons, the number of inches of oil required can readily be measured off on the gauge-board. By means of the vacuum a certain amount of oil is drawn into the cylinder and the balance is pumped in with the pressure pump The pressure pump is kept at work until the requisite amount of oil has been taken out of the working tank and pumped into the creosoting cylinder. As the vacant space in the cylinder is capable of holding only a certain quantity of oil, the balance of the oil must necessarily go into the timber.

The creosoting cylinders are tested to a pressure of 225 lbs. per square inch, and it generally requires from 150 to 160 lbs. of pressure to force 16 lbs. of oil per cubic foot into the timber.

When all the oil required has been taken from the working tank the charge remains standing in the creosoting cylinder until the pressure gauge shows about 40 to 50 lbs., then the oil required to fill the vacant space in the cylinder is allowed to return to the working tank and the charge is completed, the doors of the cylinder are opened and the charge is drawn out. In reviewing the main features of the process it will be seen that by this process timber will be thoroughly protected and preserved.

During the steaming process all moisture is evaporated and the albumen coagulated. During the vacuum process all vapors remaining in the timber and the cylinder are removed and the timber left in a condition best adapted to absorb the oil. The oil, being thoroughly heated before it comes

in contact with the timber, is readily absorbed by the open pores. The oil will penetrate the timber to the heart and fill all the pores vacated by the sap and moisture; the heavy and tarry part of the oil will remain near the outside of the timber and form an air-tight coat around each piece. As soon as the charge is taken out of the creosoting cylinder the fibers will somewhat contract, caused by the change of temperature, and the outer fibers on the sides of the stick will close themselves altogether and retain whatever oil has been absorbed.

For a number of years the Company has used at these works the oil obtained through the distillation of pitch pine—the so-called pine oil. While this oil, however, has done remarkably well as a preservative, its antiseptic qualities being very pronounced, it has been found within the last few years that it does not effectually protect timber against the ravages of the teredo and other marine borers. On this account the Company has lately used a mixture of the pine oil with dead oil experimentally. The results obtained at first were not satisfactory, but within the past year success has been attained in finding the right proportions. The constituents of the pine oil compared with the dead oil are as follows:

Dead Oil.	*Pine Oil.*
Naphthaline.	Paraffin.
Carbolic acid.	Creosote and Wood acids.

The missing part in the pine oil, as far as protection against the teredo is concerned, seems to be the carbolic acid, and the missing part in the dead oil, as far as antiseptic qualities are concerned, seems to be the creosote.

Paraffin is considered insoluble in acids, but from experience it would seem that too large a quantity of carbolic acid will have a decided influence upon it. In the combination given above, both the paraffin and naphthaline in these oils seem to have no other office than to retain the carbolic acid or the creosote and prevent their washing out.

The degree of success obtained with this process has been very encouraging, and wider extension of its use seems desirable The great obstacle so far to the introduction of any process of the kind has been the low price of lumber, which has made it apparently cheaper to renew wooden structures than to have the lumber of which they are composed treated. Whether this is really the case may fairly be questioned, and a careful computation might show that the treated lumber was cheaper in the long run. Whether this has been the case or not, there is no doubt that it will soon be so, as the timber supplies of the country are drawn upon and the price of lumber increases, as it is sure to do.

A LIGHT-DRAFT STERN-WHEEL STEAMBOAT.

THE accompanying drawing shows a small stern-wheel steamer, the *Florence Henry*, built near Seattle, Wash., for service on the Snohomish River in that State, and is interesting as showing very fully the construction of a boat of a class widely used, but not often built from carefully made drawings.

The boat was built by J. J. Holland, of Ballard, Wash., for the firm of Shepard, Henry & Company, who have the contract for building the Great Northern Railroad from Puget Sound to the summit of the Cascade Range. She was built under the supervision of Mr. George L. Cumine, Engineer for the contractors, to whom we are indebted for the drawings. She is employed chiefly for carrying supplies to the working camps along the Snohomish.

The *Florence Henry* has a hull 75 ft. long, 18 ft. beam and 4 ft. deep; the length over all, including the stern-wheel and frame, is 90 ft. 6 in. The main deck is 22 ft. 8 in. wide over all. She is flat-bottomed and of very light draft, even with a full load.

The drawings show the general design and the method of framing and bracing very clearly. Fig. 1 is a longitudinal section of the hull, with the deck-house shown in elevation; fig. 2 is a half cross-section, and fig. 3 is a plan, with the deck partly broken away to show the framing.

This class of boat is a very useful one, costing but little, carrying a large quantity of freight on a light draft, and capable of doing work where no other kind of craft can go.

The sizes of the timber used in building this boat are as follows: Main keelson, 4 × 10 in.; cylinder timber keelson 4 × 7 in.; trusses, chord, 3 × 5 in.; bracing, 2½ × 4 in.; bilge-strake, 2½ × 8 in.; knuckle-strake, 4 × 9 in.; deck-beams, 1¾ × 3¾ in.; plank-shear, 1½ × 8 in.; bottom planking, 1¾ × 12 in.; side planking, 1¾ × 6 in.; main-deck plank, 1¼ × 4 in., matched; cylinder timbers, 5 × 13 in.; wheel arms, 2 × 4 in.; buckets, 1½ × 12 in.; braces, 2 × 2 in.; rudder stalks, 2½ in. round; king-post tapered from 9 in. to 6 in.; carlins and studding for freight-house, cabin and pilot-house, ⅞ × 3 in.; upper deck plank, ¾ in., and sides, ½ in; deck stringers, 1¾ × 6 in. The upper deck is covered with canvas over the planking.

The siding for the freight-house and cabin and the upper deck planking are of cedar; the rest of the timber is Washington fir.

The running rope for the steering-gear is ¾ in., of steel wire. The pilot wheel is 5 ft. in diameter. The hog-rods are 1 in. in diameter. The braces to the wheel-frames are ⅝-in. rods. The frames and planking are secured by screw bolts and spikes.

The stern-wheel is 12 ft. 6 in. in diameter over all and 11 ft. face. There are 14 buckets, each 1 × 11 ft. in size. The wheel-shaft is 4½ in. in diameter, with crank at each end, as shown.

The wheel is driven by two horizontal engines, the cylinders being 9 in. in diameter and 40-in. stroke. Steam is furnished by an Almy tubulous boiler having 12.8 sq. ft. grate area. The usual working pressure is 200 lbs. The fuel used is wood, with a little coal occasionally, and the boiler is found to supply plenty of steam. The engines are usually run to cut off at half-stroke, sometimes increased to three-quarters, when the work is hard.

THE FOLSOM DAM.

FROM a long and interesting article in the Sacramento *Union* the following description of the great dam and water-power on the American River at Folsom, Cal., is condensed:

As long ago as 1866 the foundation was laid for this dam across the American River, at a point about two miles above Folsom and one-third of a mile above the locality where was subsequently located the Folsom State Prison. The work has been continuously in progress, either on the dam or the canal leading from it. In 1868 the State of California became interested in the work, receiving a conveyance of the site for a prison, and a grant of water-power privileges on the canal, at the said prison, in consideration of giving the aid of convict labor in the construction of the dam and canal.

In 1874 additional concessions of lands were received by the State, enlarging the site for its proposed State Prison, in consideration of additional grants of convict labor to construct the work. Owing, however, to unforeseen delays in the completion of the prison, it was not until 1881–82 that the State commenced to discharge its contract to furnish convict labor.

The Folsom Water Power Company had, in the mean time, acquired the property from the original owners, with all its franchises and contract rights. Differences of interpretation as to the contract of the State to furnish convict labor led to litigation, wherein the decision was against the State, and a temporary suspension of work by the State convicts followed.

The late Governor Waterman, advised thereto by the energetic and clear-sighted Warden of the Folsom Prison, Charles Aull, recognized that most valuable interests of the State were being allowed to lie dormant, perhaps ultimately to be entirely sacrificed, and on the Governor's initiative, backed by the active co-operation of the then Board of State Prison Directors, a new contract was entered into on May 5, 1888, between the State and the Folsom Water Power Company, providing for a large increase in the magnitude of the dam and canal, for a proportion-

ally more ample water-power privilege to the State at the prison, and for a necessarily increased contribution of convict labor by the State.

Under this modified contract, work was at once actively commenced, and has been since vigorously prosecuted with all the force of the labor available at Folsom Prison, and of an immense outfit of steam machinery furnished and operated by the Folsom Water Power Company.

Additions to the dam, head-gates and retaining wall of Section 1 of the Eastside Canal have made the work one of far greater magnitude than was at first contemplated, entailing a proportionate increase of time in construction.

The dam, head-gates and Section 1 retaining walls, down to the location of the State Power House, were, however, finally finished some months since, and are of an

The work remaining now to be done, for the completion of Section 1 of the canal, is the construction of the walls, gates, etc., connecting the State Power House, both at the inlet and outlet, with the canal; also of a railroad bridge across the canal to give the State access to the prison yard and quarries. This work, it is expected, can be completed in three or four months.

When so completed the entire force will be transferred to Section 2 of the canal, and as this portion of the work is entirely excavation and dry retaining wall of rubble, it has none of the difficult features which have made Section 1 so long in construction. It is therefore considered reasonable to calculate that the balance of the canal may be completed, to the Folsom terminus of the canal, in about one year from the time work is commenced on Section 2.

THE FOLSOM DAM, AMERICAN RIVER, CALIFORNIA.

extent and stability scarcely equaled by any similar work in the world. For a more full understanding of these works the following details are instructive:

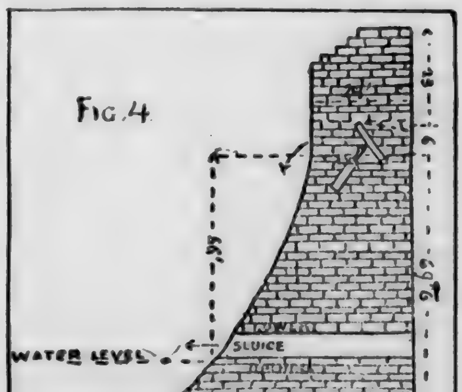
The height of the dam is 89 ft.; width on top, 24 ft.; width on bottom, 87 ft.; length, 650 ft.; masonry contents, 48,590 cubic yards. The material is granite blocks of the most solid character and of the largest dimensions, laid in the best of English Portland cement, of which over 20,000 barrels were consumed in the dam and head-works.

The head-gates to the Eastside Canal are three in number, each being 16 ft. wide. The head-gates to the Westside Canal are also three in number, each 15 ft. wide. The Eastside Canal is 50 ft. wide on top, 35 ft. wide on the bottom and 8 ft. deep. The Westside Canal is 40 ft. wide on top, 30 ft. wide on the bottom, and 6 ft. deep.

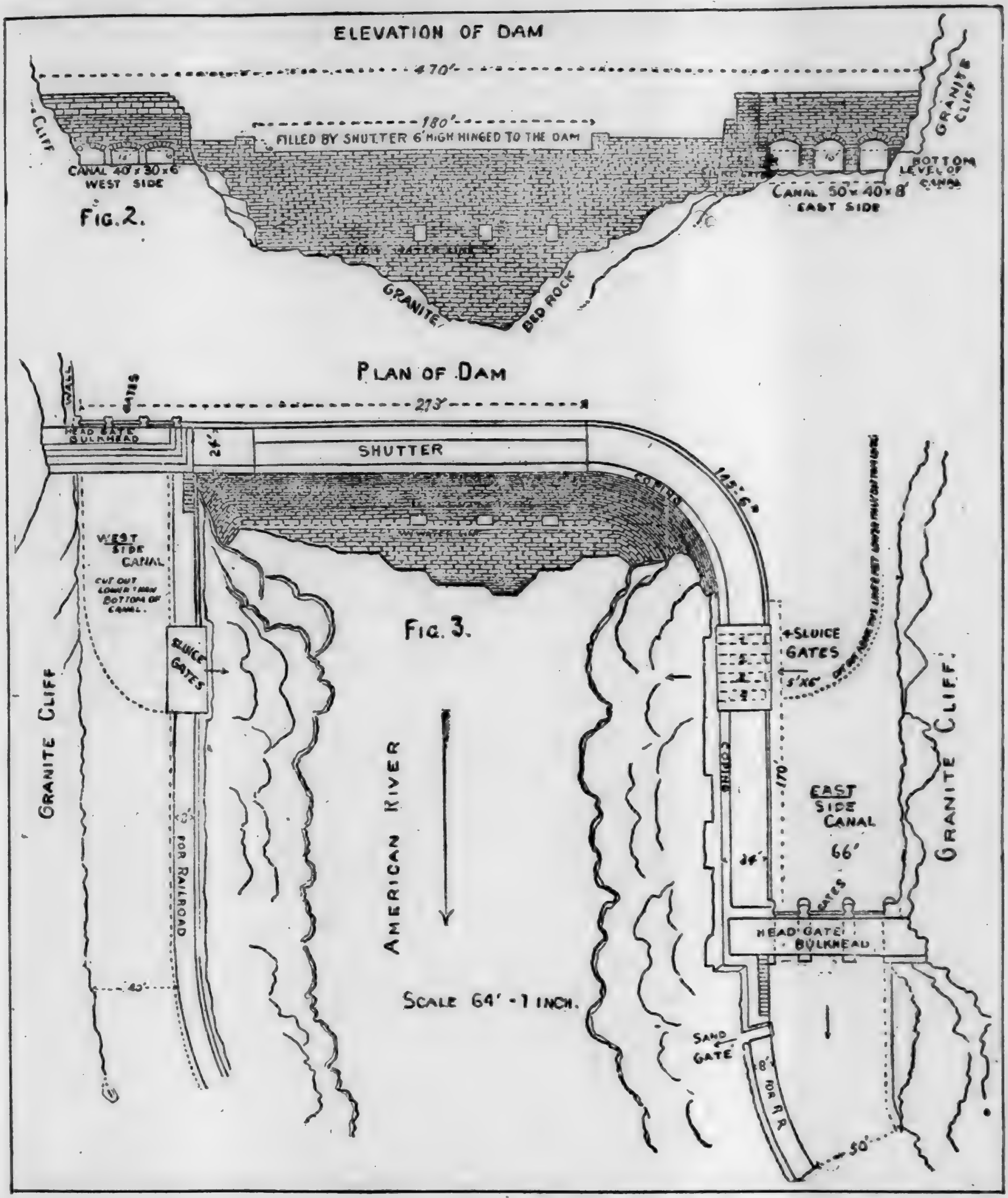
The work on the State Power House, situated on the State Prison grounds, at the end of Section 1 of the Eastside Canal, designed for the utilizing of the power at the State Fall, has occupied the entire attention of the working force for the past year, and has, like the dam and head-gates, proved a much larger undertaking than was calculated upon. Not until its completion can the dam and head-gates be utilized for the diversion of the waters of the river, since all the water taken into the canal at the dam must pass through the wheels of the State Power House, where there is a fall of 7.33 ft., yielding to the State upward of 800 H.P.

The State Power House proper is now practically finished, and its machinery nearly all placed therein, forming one of the most unique examples of mechanical achievement to be seen anywhere in the United States.

The fall of the American River, from the dam to the Folsom terminus of the canal, is 82 ft., and there will be upward of 70 ft. of fall available at the Folsom terminus for power purposes. This will afford 7,707 H.P., which,



on the basis of 75 per cent. actual efficiency of the water-wheels, will yield 5,770 H.P. effective.



Should it, for any reason, be deemed desirable, power may be developed at the end of Section 1 immediately upon its completion. At this point the canal must be discharged back into the river during the construction of Section 2. There is here a fall of 35 ft. and upward, which would develop upward of 2,000 effective H.P. were it decided to develop the power here, temporarily, without waiting for the completion of the canal to the Folsom terminus.

It is probable that this course will be adopted, in order to furnish power to the mills and factories of the American River Land & Lumber Company, with whom the Folsom Water Power Company has made a contract to furnish mill sites, power, etc., on its canal near the Folsom terminus.

It is contemplated, however, that most of the power will find its market in Sacramento City, transmitted there by electricity, the distance being about 20 miles in an air-line.

Arrangements to this end have already been perfected whereby the Sacramento Electric Power & Light Company will, by contract with the Folsom Water Power Company, receive a large portion of the power of the latter company, and, converting it into electricity, will transmit it to Sacramento City, there to be used for the lighting of the city and furnishing motive power for street cars, and for manufactures of all kinds.

Still more extensive plans, however, are entertained by the Company. It is proposed to use the water-supply not only for power, but also to supply the city of Sacramento and to furnish water for irrigating lands throughout the valley. The dam is situated 210 ft. above the level of the sea, and is therefore about 175 ft. above the level of Sacramento City. The basin, or reservoir, above the dam is upward of three miles long, and has an area of 5,850,000 surface feet. The dam is fitted with a timber shutter, operated by hydraulic cylinders, and which, when closed, will raise the water 6 ft. over the entire area, giving an additional storage of 35,100,000 cub. ft. This, it is be-

lieved, will be sufficient to provide against the contingencies of the dry season, and to give, with the usual daily flow of the river, a supply ample for the purposes indicated.

In the illustrations herewith fig. 1 is a sketch of the dam and head of canal; fig. 2 is an elevation; fig. 3 a plan of the works, and fig. 4 a section of the dam. In adopting this section, the stability of the dam was calculated at about four times the estimated thrust of the water behind it.

TWO-CYLINDER VERSUS MULTI-CYLINDER ENGINES.

(Paper by S. M. Green and George I. Rockwood, presented at the San Francisco meeting of the American Society of Mechanical Engineers.)

In a paper in the RAILROAD AND ENGINEERING JOURNAL of December, 1891, the theory was advanced by Mr. Rockwood that more than two cylinders in a compound multi-cylinder engine were unnecessary to secure the highest theoretical economy in the use of steam. This proposition was severely criticised, and declared to be inconsistent with the modern philosophy of the steam engine. It may, therefore, be interesting to give an account of a series of tests of a triple-expansion engine so constructed as to permit cutting the intermediate cylinder out of the circuit and running the high-pressure and low-pressure cylinders as a two-cylinder compound, using the same conditions of initial steam pressure and load.

The engine is a triple-expansion, condensing engine, designed by George I. Rockwood for the Merrick Thread Company, Holyoke, Mass., and built by the Wheelock Engine Company, Worcester, Mass. The high-pressure and intermediate cylinders are tandem on one frame, the low-pressure cylinder occupying the right-hand position to an observer standing at the cylinder and looking toward the shaft.

The relative proportions of the cylinders are somewhat novel. As the objects of the designer were to secure an engine of symmetrical appearance, of uniform turning moment at each crank, and of highest attainable steam efficiency, and also to make it possible to run the low-pressure side with high-pressure steam, in case of accident to the high-pressure side, the tandem cylinders were made of shorter stroke than that of the low-pressure cylinder. The high-pressure cylinder was put next to the frame. The exhaust steam from the high-pressure cylinder passes directly into a receiver of the tubular re-heater variety, and thence directly into the intermediate cylinder. Another similar receiver lies between the intermediate and low-pressure cylinders. These two receivers are so connected that the exhaust from the high-pressure cylinder may pass through both into the low-pressure cylinder without going through the intermediate cylinder, the steam and exhaust pipes of which are provided with valves. The first and second cylinders are jacketed on heads and barrels; the heads only of the low-pressure cylinder are jacketed, and all receiver and cylinder jackets contain steam at full boiler pressure. The cylinder jackets consist of cored spaces. The jacket-drips all collect into one pipe 1½ in. in diameter, which discharges into a reservoir, whence it is returned through a steam loop to the boiler, and in no instance are the jackets connected with the cylinder steam-chests.

The valve-gear of the high-pressure cylinder is of a new type, designed to operate gridiron valves under heavy pressures. The valve gears of the intermediate and low-pressure cylinders are, in all respects, such as have been used heretofore on engines built by the Wheelock Engine Company. The governor operates only upon the cut-off mechanism of the high-pressure cylinder, the releasing gears of the other two cylinders having independent hand adjustments. In case of accident to the high-pressure side of the engine, however, means are provided for connecting the governor with the cut-off mechanism on the low-pressure cylinder.

The engine is located at some distance from the boiler (a Manning upright of 175 rated H.P.), the supply pipe being 325 ft. in length. A separator, placed about 10 ft. from the engine, collects the entrained and condensed water, which is also returned through a steam loop to the boiler. The condenser is of the jet type, supplied from the canal with injection water, which is removed by a direct-connected air pump.

The dimensions of the engine are as follows:

	H.P.	I.	L.P.
Diameter of cylinder	12″	16″	24$\frac{13}{32}$″
" " piston rod	2 and 2¾″	2″	3¼″
Stroke of piston	36″	36″	48″
Clearance in percentage of piston displacement	2%	4%	3%
Inside diameter steam pipe	5″	6″	9″
" " exhaust pipe	6″	7″	10″
Area of steam port	13″	21″	38″
" " exhaust port	16.5″	25″	60″

It was considered unnecessary to make coal measurements, as they have no bearing on the results.

The feed-water was measured in the following manner: One large tank was employed as a reservoir, from which the feed-pump drew its supply. Above this tank, on a platform, were placed a pair of scales and a small tank which held about 400 lbs. of water. (Just before the trials the scales were sealed by the Sealer of Weights and Measures.) To the beam of these scales was attached a long pointer. They were accurately balanced with the tank empty, and the position of the pointer was noted and marked. A scale weight of 400 lbs. capacity was then placed on the beam, and water was run into the tank until the pointer resumed its balanced position, thus giving just 400 lbs. of water in the tank. A small valve was provided in the side of the weighing tank, so that any water which might run in, in excess of the 400 lbs., could be readily withdrawn. A counter was also attached to the tank, so that every filling would be automatically registered independently of the attendant's registration. In this way an accurate count was kept of all the water pumped into the boilers. The boiler feed-pump was connected only with the reservoir and feed-pipe to the boiler used during the tests. Steam for this pump was taken from other boilers.

During the period of testing, the water of condensation from the jackets was not allowed to return to the boilers, but was drained through pipes connected with the lowest points in each of the jackets, each pipe leading down to a separate reservoir provided with a gauge glass. The discharge pipe, ½ in. in diameter, from each reservoir, was connected with a surface condenser and discharged into a weighing tank. An accurate record was kept of all water drawn from each jacket during each test. A revolution counter indicated accurately the number of revolutions of the engine. Six Tabor indicators were kindly loaned for these tests by the Ashcroft Manufacturing Company, of New York. The instruments were all in the best condition and were sent directly from the factory. The springs used in the indicators were tested under steam pressure with a steam-gauge which had itself just been tested with a mercury column. The springs used in the indicators on the low-pressure cylinder were compared with the mercury column employed instead of a vacuum-gauge. The steam-gauges were also tested with a test-gauge.

For determining the quality of the steam after passing through the separator a Peabody throttling calorimeter was connected with a perforated ½-in. pipe, screwed several inches into the elbow of the steam supply pipe at its point of juncture with the high-pressure cylinder, the connections and calorimeter being thoroughly covered with hair felt.

The following description of the tests will illustrate the manner in which each trial was conducted.

At 1 P.M., the engine having been running for 15 minutes, electric bells were sounded in the engine and boiler rooms, the heights of the water in the boiler and in the lower tank were measured, the reading of the scale counter was noted, the heights of water in the various jacket reservoirs were taken, and the test began.

During the trials, simultaneous indicator diagrams lasting ½ minute were taken every half hour, which was considered often enough in view of the exceedingly steady

load on the engine; and pressures and temperatures were carefully noted each time. Every hour the water in the boiler and tank was brought to the heights observed at the time of starting the test, and observations were made for a check on the final result. Just before the time of closing, the boiler pump was stopped, the water in the boiler was allowed to fall below the point of starting, and at precisely six o'clock the bells were sounded, the engine shut down, and steam was shut off from the jackets. The heights of the water in boiler and tank were brought to the same level as at starting.

Three preliminary tests of the engine were thus run, in order to accustom the attendants to their duties. In all the tests made, the reading of the thermometer in the calorimeter was practically constant, showing a uniform degree of moisture in the steam amounting to 2.64 per cent.

On Wednesday, April 6, two five-hour formal trials of the engine, run as a two-cylinder compound, were held. During Thursday, a holiday, the change was made to a triple-compound, and on Friday two five-hour trials were again made.

The general results are given in the table below—tests A and B being those made with the engine running compound, and C and D with the three cylinders:

Test.	R. P. M.	Average Steam-Pipe Pressure.	Average Indicated Horse-Power.	Water per I. H. P. per Hour	Dry Steam per I. H. P. per Hour.	Weight of Water used in Jackets, per Hour.
				Lbs.	Lbs.	Lbs.
A....	79.2	142.	187.11	13.41	13.06	330.3
B....	79.3	142.	180.71	13.11	12.76	330.3
C....	79.0	142.	199.08	13.01	12.67	416.0
D...	79.0	143.	178.16	13.25	12.90	388.8

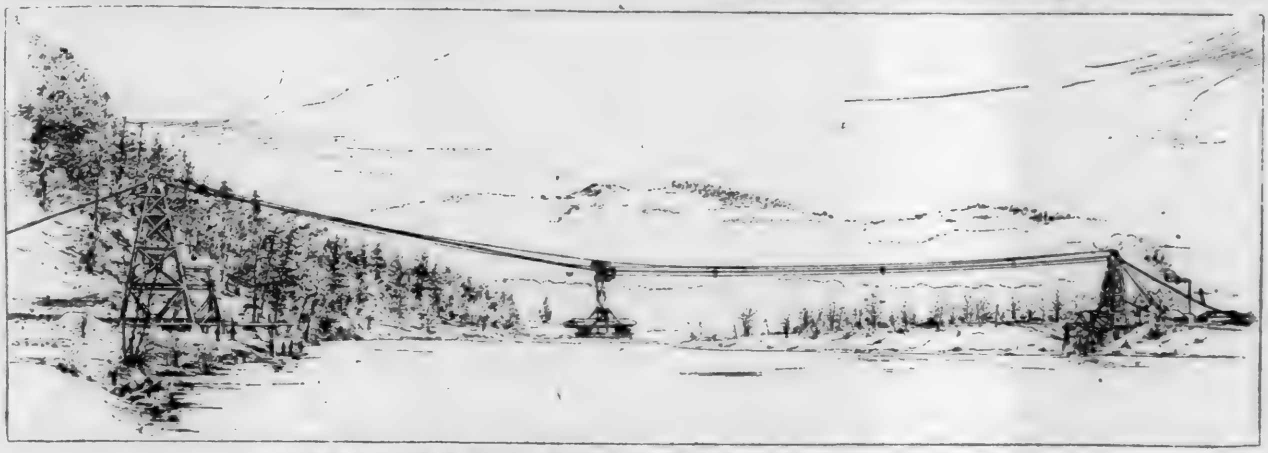
These results are practically identical, and would seem to support Mr. Rockwood's theory that the receiver may be so constructed as to take the place of the intermediate cylinder or cylinders of the multi-cylinder engine. As these tests were held so shortly before the spring meeting of the Society, the time allowed in which to prepare this paper was much too limited to admit of the exhaustive treatment which the importance of the subject demands. It is hoped that at the next meeting the results of further trials, together with their proper analyses, may be presented for further consideration. But the results of these tests, it is believed, show an economical performance surpassing the best records hitherto published in this country, and clearly indicate that more than two cylinders are unnecessary to secure the highest attainable economy in the use of steam.

A NOVEL CABLE TRANSFER.

(Condensed from paper read by E. G. Spilsbury before the American Institute of Mining Engineers.)

A FEW miles above Williamsport, Pa., on the Susquehanna River, the Glen Union Lumber Company, of Pottsville, Pa., owned a large tract of valuable timber land. Unfortunately, it is on the right bank of the river, while the railroad, the only available means for carrying the lumber to market, runs on the left bank. The river is about 750 ft. wide at this place, and the cost of a bridge to carry the cars over was practically prohibitory, as it threatened to consume the profits of the business for many years. Several plans for obviating the difficulty, such as a ferry or a floating bridge, were proposed; but these were considered impracticable by reason of the rapid floods and ice gorges to which the Susquehanna is subject. The problem was submitted to the writer, who proposed as a solution, and subsequently put up, one of the Trenton Iron Company's cable hoists. This transfer has now been in successful operation for over a year, and has thoroughly proved the capacity of the system to take loads of 20 or 30 tons over very long spans.

The work to be done was to take the loaded cars from the tracks on which they were brought down to the river



CABLE TRAMWAY ACROSS THE SUSQUEHANNA RIVER.

bank, and to deliver them without unloading on the tracks of the Philadelphia & Erie Railroad on the opposite shore. The shortest span which could be obtained was 733 ft. The accompanying sketch shows the general construction. Two 70-ft. towers were erected, one on each bank, and over the tops of these were stretched two steel cables each 2 in. in diameter, each cable having a breaking strain of about 125 tons. In order to equalize the strains on these cables, and so keep them always parallel, they were made in one continuous length, the two loose ends being anchored rigidly on the railroad side of the river, and the bight at the other end passing round a 6-ft. sheave, revolving in a shackle attached to the anchorage on the other bank. On these cables runs a carriage supported on four wheels, and moved back and forth by means of an endless cable 1 in. in diameter. In the lower part of this carriage are placed the hoisting-sheaves, which, in conjunction with a large fall-block, hoist the load vertically, high enough to free it from the tracks at each end and from the river at its highest stage in the middle. A wrought-iron lattice-work cage, 36 ft. in length and fitted with tracks, receives the car at each end. The sag of the hauling-ropes and also of the hoisting-rope, which on so long a span would be very great, is taken up by a number of fall-rope carriers of the Locke patent design. Indeed, the whole arrangement of carriage and fall-blocks is only a modification of Locke's system to meet the special requirements of the case. The power required to operate the system is furnished by a 50-H.P., specially designed engine, built by the Lidgerwood Manufacturing Company. The total load carried is about 26 tons, including the cage and car; the estimated load of lumber being 12 tons. The trip across the river is made in about three minutes. The total cost of the whole structure completed was less than one-fifth the cost of a bridge, even of the lightest design.

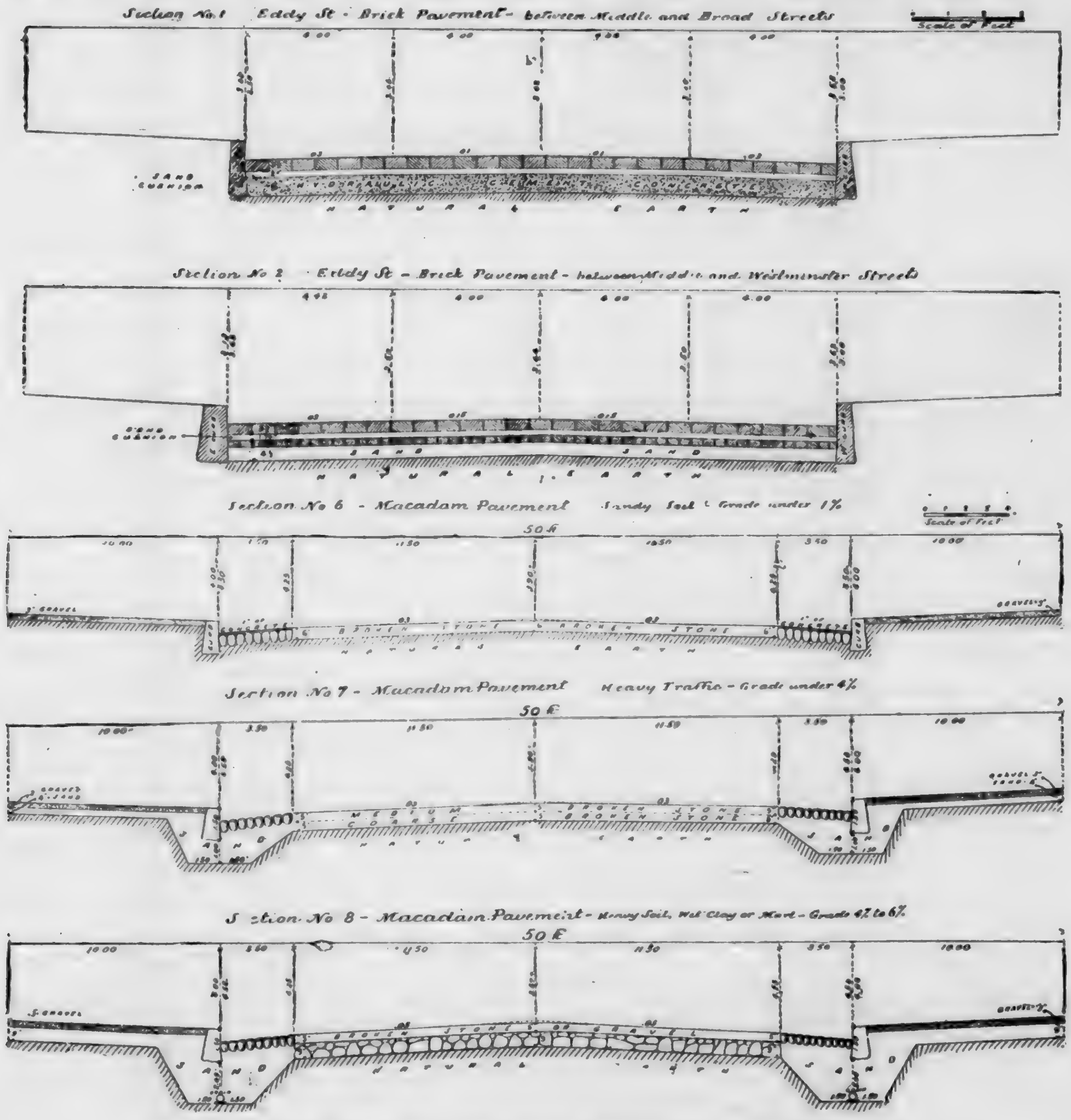
During its operation last winter and spring, no delays occurred from ice-gorges or freshets. After it had been running for some months, however, it was found that the wear on the tread of the carriage-wheels was very great. This was obviously due to the uneven surface of the ropes, which tended to cut a spiral thread on the grooves corresponding

to the lay of the strands in the rope. Of course, it would not do to make these wheels of harder material than the rope, since it is cheaper to replace them than it would be to wear out the rope; but, at the same time, the cost of replacing the wheels threatened to lessen greatly the economy of the whole system. Hence, it has now been determined to replace the two main cables of the ordinary make by two of the smooth-coil Elliot locked-rope cables, the use of which entirely obviates all this wear on the wheels. These ropes are now being manufactured, and I hope to present, at some future meeting, figures thoroughly demonstrating the great advantages of these ropes over all others for just such purposes.

SOME GOOD ROAD SECTIONS.

FOR the accompanying diagrams, showing cross-sections of streets laid with brick pavement, and cross-sections of macadamized roads, we are indebted to the annual report of Mr. J. Herbert Shedd, City Engineer of Providence, R. I. They are good specimens of careful work.

Sections No. 1 and 2 represent brick pavement laid in Eddy Street. This pavement was laid as an experiment, being the first brick pavement laid in a roadway in the city. It was laid in four different ways; one-half of the pavement (see Section No. 1) having a hydraulic cement concrete foundation, the other half (see Section No. 2) having brick laid flat and lengthwise of the street. The bricks forming the wearing surface were laid edgewise and across the street on a cushion of sand about 2 in. in depth. A portion of the joints was filled with sand and another portion was filled with a paving cement, composed of coal-tar pitch and ordinary paving cement in the following proportions: One barrel of coal-tar pitch and one-half barrel of cement.



SECTIONS OF BRICK AND MACADAM ROADWAYS, PROVIDENCE, R. I.

Sections No. 6, 7 and 8 represent macadamized streets. The cross-section or crown in each case is made to conform to the longitudinal grade, so as to carry the surface water coming to the street to the gutters as quickly as possible; the transverse rate varying from .03 to .08 per foot.

Section No. 6 represents a cross-section of a street having light traffic. The natural material found at sub-grade is sand. The cobblestone used for gutters is covered with

concrete top-dressing where the grade is less than 1 per cent.

Section No. 7 represents a cross-section of a street having heavy traffic, and where the material found at subgrade is clay, marl, or of such a nature as is liable to be affected by the frost. The broken stone in this street is laid in two layers, the lower layer being composed of the coarsest stone taken from the crusher, and is rolled thoroughly into place by the heavy steam roller.

Section No. 8 represents a cross-section of a street where the material found at sub-grade is heavy soil or wet clay, the lower layer being composed of refuse stone, placed loosely, so as to underdrain the roadway. The upper layer of broken stone is then applied and thoroughly rolled.

ALUMINUM AND ITS USES.

(Condensed from lecture by Alfred E. Hunt, C.E., in the *Journal* of the Franklin Institute.)

ALUMINUM is now being made throughout the world upon a commercial scale only by processes of electrodeposition from fused electrolytes. In this country, the Pittsburgh Reduction Company and the Cowles Electric Smelting & Aluminum Company are the only concerns manufacturing commercially and furnishing the American market with aluminum. In Great Britain, the Metal Reduction Syndicate, Limited, a branch of the Pittsburgh Reduction Company; and in Switzerland, the Aluminium Industrie Actien Gesellschaft, manufacturing at Neuhausen, using the water-power of the falls of the Rhine; and in France, the firm of Bernard Brothers, now building works at St. Michaels, and operating the Minet process, are, so far as the writer's knowledge goes, the only manufacturers now whose metal is met in the competition of the world's rapidly growing market for aluminum. These statements need to be made preliminary to any considerations of the purity or other qualities of the commercial aluminum of the markets of the present day, for the reason that manifestly it will not be fair to take into consideration, in treating of the commercial aluminum of to-day, the impure products made only on a small scale by the great number of processes being experimented upon.

Both the Neuhausen concern and the Cowles, as well as the Metal Reduction Syndicate, Limited, of Patricroft, Lancashire, England, and the Pittsburgh Reduction Company, find no trouble by the electrolytic process in producing regularly metal with less than 1 per cent. of impurity. Indeed, the best results in quantity of output and regularity of working, and therefore in economy of manufacture, are when producing the purest aluminum, and it only requires further development of the manufacture of the aluminum oxide used as the ore and of the carbon anodes —matters which are perfectly practicable and possible—to obtain almost absolutely chemically pure aluminum by the electrolytic methods now in use.

I have already, in a previous lecture, in February, 1891, before the Boston Society of Arts, stated that the cost of manufacture, under the most favorable conditions with water-power and large output, would be approximately 20 cents per pound. Nearly one year's experience and careful study of the matter leads me to reiterate the statement then made, and to prophesy that the ingot metal will be made by the Hall process within the next few years at *a cost* of between 18 and 20 cents per pound; the items of cost being about one-third for the ore, one-sixth for the expenditure of other materials than ore, one-third for the electrical current expended, one-twelfth for labor and superintendence, and one-twelfth for general expenses, interest and repairs.

Aluminum will not be manufactured by any process at much less than at present, nor will it be sold at much lower rates, until the output be measured in tons, and not pounds, per day. The lowering of the market price of aluminum in the future will be gradual, and will be directly proportionate to the decrease in cost of manufacture, due to increased capacity of the manufactories.

The properties of aluminum which will probably give it the greatest availability in the arts are:

1. Its relative lightness.
2. Its non-tarnishing quality as compared with many other metals; aluminum not being acted upon by sulphur fumes at all, and being very much more slowly oxidized by moist atmospheres than most of the metals.
3. Its extreme malleability.
4. Its easy casting qualities.
5. The influence of the metal in various alloys will give it advantages, some of which I will try to enumerate and call to your attention.
6. Its high tensile strength and elasticity when weight for weight of the metal is compared with other metals, and especially when alloyed with a small percentage of titanium, silver or copper and properly worked by being rolled or hammered or otherwise drawn down.
7. Its high specific heat and electrical and heat conductivity.

Unfortunately, aluminum is not, section for section, as has been widely claimed, comparatively a very strong metal. It is only about as strong under tensile strain, section for section, as cast iron, and has less than one-half the strength of wrought iron under ordinary conditions. Under compression, the metal, unfortunately, has a very low elastic limit, although its extreme ductility allows the metal to flow on itself so freely as to make it for special purposes a very safe metal to use in compression.

The same remark applies to transverse tests of aluminum. It is not a rigid metal at all, and bends under transverse strains very readily.

Under torsional stress, the metal has much lower modulus of rigidity than iron or steel; its maximum shearing stress in castings is about 12,000, and in forgings about 16,000, being about that of pure copper. The angle of torsion is about equal to that of the softest steel.

The tensile strength of aluminum wire runs up very considerably over that of the rolled metal. This is due to the peculiar property of aluminum to harden under work. The metal requires frequent annealing in rolling; and if it is to be drawn into wire with as little annealing as possible, the tensile strength is increased very considerably. This property of the metal is increased, especially if the aluminum is alloyed with a small percentage of copper, titanium or silver.

Two things, however, should always be borne in mind in considering the applicability of aluminum for given purposes in the arts. The first is that the properties of the metal are very considerably changed as regards strength, tenacity, hardness, rigidity and color, by alloying it with small percentages of other metals, conditions that do not materially change the specific gravity of the metal. The second is the relative weight of aluminum; taking the tensile strength of aluminum in relation to its weight, it is in plates as strong as steel at 80,000 lbs. per square inch ultimate strength, and in cold-drawn wire as strong as steel at 180,000 lbs.

The specific gravity of aluminum is one of its most striking properties; it varies from 2.56 in ingots to 2.70 in forged bars. The weight of a given bulk of this metal compares with others as follows:

Aluminum	1.00	Nickel	3.50
Wrought iron	2.90	Silver	4.00
Structural steel	2.95	Lead	4.80
Copper	3.60	Gold	7.70
Ordinary high brass	3.45	Platinum	8.60

A cubic inch of cast aluminum weighs 0.092 lb.; of rolled sheet metal, 0.098 lb.

Wherever momentum is to be overcome, as in the reciprocating parts of many forms of machinery, aluminum can be advantageously used.

Aluminum does not oxidize so as to interfere at all with the strength of thin sections of the metal as do iron and steel; the thin film of oxide which covers surfaces of the metal which have been long exposed to moist atmosphere seems to prevent its being further acted upon. But it does give a surface tarnish to the metal which cannot be rubbed off with the usual metal polishing compounds without interfering with the surface of the soft metal. This, however, can be removed by rubbing with a flannel rag which has been immersed in a 2 per cent. solution of hydrofluoric acid and then again rubbing up the polish

with a rag saturated with carbon oil. Special aluminum polishes have been devised which work very efficiently. When properly cared for, polished surfaces can thus be kept bright for a remarkably long time.

As compared with most metals, pure aluminum, under ordinary circumstances, withstands the action of wind and weather exceedingly well; and many uses to which the metal is now being successfully applied are based upon this fact. The presence of silicon in aluminum materially detracts from its power to withstand corrosion due to atmospheric influences. Metal with 4 per cent. or 5 per cent. of silicon very soon collects a thick coating of oxide upon it, if severely exposed. The fact that pure aluminum is not severely acted upon by boiling water or by steam has led to its successful use as a packing or gasket in steam connections, where lead and similar metals have been rapidly cut out, as in parts of steam and water pumps and difficult steam joints.

For structural purposes under water, where metals are required, aluminum seems to be especially adapted to replace the more easily corroded cast and wrought iron and steel now in general use for such purposes. For liners and shims upon masonry foundations, aluminum is well adapted, as it flows sufficiently to allow equal bearings on all parts; it is less easily cut out than lead, and much more durable than tinned iron sheets which are now in general use under heavy structures of metal resting on metal shims on masonry.

Aluminum sheets will make a much more durable and satisfactory roofing than sheet copper now generally used in valuable buildings.

Pure aluminum is very sonorous, and its tone seems to be improved by alloying with a small percentage of silver or titanium. For the sounding-boards of musical instruments, aluminum has been proven to be well adapted.

Pure aluminum, when properly treated, is a very malleable and ductile metal. It can readily be rolled into sheets 0.0005 in. thick, or be beaten into leaf nearly as thin as gold leaf, or be drawn into the finest wire. Pure aluminum stands third in the order of malleability, being exceeded only by gold and silver; and in the order of ductility, seventh, being exceeded by gold, silver, platinum, iron, soft steel and copper. Both malleability and ductility are greatly impaired by the presence of the two common impurities, silicon and iron.

Aluminum can be rolled or hammered cold, but the metal is most malleable at and should be heated to between 350° and 400° F., for rolling or breaking down from the ingot to the best advantage. Like silver and gold, aluminum has to be frequently annealed, as it hardens up remarkably upon working. Due to this phenomenon of hardening during rolling, forging, stamping, or drawing, the metal may be turned out very rigid in finished shape, so that it will answer excellently well for purposes where the annealed metal would be entirely too soft, or too weak, or lacking in rigidity to answer. Especially is this true with aluminum alloyed with a small percentage of titanium, copper or silicon. It can be safely stated, as a general rule, that under similar conditions the purer the aluminum, the softer and less rigid it is.

Aluminum can be annealed by heating and allowing to cool gradually; the best temperature is just below the red heat. Thin sections can be annealed by heating in boiling water.

Aluminum can be easily and readily welded by electrical apparatus, and a cheap and satisfactory solder has been discovered.

Sound castings of this metal can be made in dry sand moulds or metal chills. It requires, however, some experience to master its peculiarities before sound castings can be uniformly made. The aluminum should not be heated very much beyond the melting point; if too hot it seems to absorb gases which remain in the metal, preventing sound castings. In small quantities the metal can be best melted in plumbago crucibles; but in large quantities it can be more economically melted in a reverberatory furnace with alumina or magnesia brick sides and alumina bottom. The furnace should have a tap-hole for drawing off the liquid metal into carbon-lined ladles. In no case need the metal be covered with a flux to assist in the fusion or to form a covering of slag. In fact, owing to the metal's lightness, the presence of any flux will tend to unsoundness, due to particles of it becoming entangled in the castings, while impurities may perhaps be added to the metal by the action of the flux on the lining of the melting vessel. The shrinkage of $\frac{17}{64}$ in. per foot, which aluminum has, is considerably more than that of brass, which is about $\frac{3}{32}$ in. per foot.

Undoubtedly, one of the greatest uses for aluminum in the arts will be in the form of alloys with other metals. Aluminum in proportions of a small percentage added to very many different metals gives valuable properties. Among these alloys is, of course, aluminum bronze. The alloys of from 2½ per cent. to 12 per cent. aluminum with copper have so far achieved the greatest reputation. With the use of 8 per cent. to 12 per cent. aluminum in copper, we obtain one of the most dense, finest-grained and strongest metals known, having remarkable ductility as compared with its tensile strength. A 10 per cent. aluminum bronze can be made in forged bars with 100,000 lbs. tensile strength, 60,000 lbs. elastic limit, and with at least 10 per cent. elongation in 8 in. An aluminum bronze can be made to fill a specification of even 130,000 lbs. tensile strength and 5 per cent. elongation in 8 in. Such bronzes have a specific gravity of about 7.50, and are of a light yellow color. For cylinders to withstand high pressures, such bronze is probably the best metal yet known.

A small percentage of aluminum added to Babbitt metal gives very superior results, increasing the durability and wearing properties of the alloy. It is a little softer than the ordinary Babbitt, but in comparative tests has given very satisfactory results. One advantage of this alloy is its extreme malleability. It can be hammered out to a thin edge without cracking. An advantage of this is that for bearings the aluminum Babbitt can be rolled into shape for inserting in the dove-tailed recesses, which can be cut and drifted out at a very small expense, and the amount of Babbitt required is reduced to a minimum.

Aluminum is also being used very successfully in steel castings, and has added very considerably to the progress which has been made within the last two years in obtaining sound steel castings. A large number of steel casting companies are regularly using the metal aluminum in quantities of from one-half pound to several pounds of aluminum to the ton of steel. In the manufacture of ordinary steel ingots by the open-hearth and Bessemer processes, it has lately been shown in the article on "Aluminum in Steel Ingots," by Professor J. W. Langley, at the January, 1891, meeting of the American Institute of Mining Engineers, that the use of aluminum in small proportions (from one-third to three fourths of a pound of aluminum to the ton of steel) has proved to be an economical success, preventing blow-holes and unsound tops of ingots.

Alloys of aluminum with copper in proportion of from 2 per cent. to 15 per cent. have been advantageously used to harden aluminum in cases where a more rigid metal is required than pure aluminum. Copper is one of the most common metals used at present to harden aluminum. A small percentage of copper decreases the shrinkage of the metal and gives alloys that are especially adapted for art castings. The remainder of the range, from 15 per cent. copper up to over 85 per cent., give crystalline and brittle alloys of no use in the arts; which are of a grayish-white color, up to 80 per cent. copper, where the distinctly yellow color of the copper begins to show itself.

With the exception of lead, antimony and mercury, aluminum unites readily with all metals; and many useful alloys of aluminum with other metals have been discovered within the last few years, and I prophesy that many more will be found within the next few years. I consider this field as one of the most promising for investigation of any of the "aluminum problems." The useful alloys of aluminum so far discovered are all in two groups, the one of aluminum with not over 15 per cent. of other metals, the other of metals containing not over 15 per cent. of aluminum; in the one case, the other metals imparting hardness and other useful qualities to the aluminum, and in the other, the aluminum giving useful qualities to the other metals.

Titanium and chromium can be readily alloyed with

aluminum according to methods devised and patented by Professor John W. Langley. This will probably prove to be the most valuable means of hardening aluminum; a small percentage of titanium rendering the metal, under work, very rigid and yet elastic at the same time. Chromium is the best metal for hardening aluminum castings; the triple alloy being best adapted where a very hard and yet elastic material is required.

More or less useful alloys have been made of aluminum with bismuth, nickel, cadmium, magnesium, manganese and tin, these alloys all being harder than pure aluminum; but it is by combinations of these metals, with additions, perhaps, of copper, lead and antimony, that alloys of most value have so far been discovered. Some are additions of only 1 per cent. to 2 per cent. of aluminum.

The modifications of pewter, britannia, white metal, delta metal, and the like, with additions of aluminum, have shown very useful qualities, and will add very considerably to the demand for aluminum in the near future.

The following alloys have recently been found useful: Nickel-aluminum, composed of 20 parts nickel and 8 parts aluminum, used for decorative purposes; rosine, composed of 40 parts nickel, 10 parts silver, 30 parts aluminum, and 20 parts tin, for jewellers' work; sun-bronze, composed of 60 parts cobalt, 10 parts aluminum, 40 parts copper; mètalline, 35 parts cobalt, 25 parts aluminum, 10 parts iron and 30 parts copper.

Professor Emmens has great hopes for an alloy of aluminum-bronze and nickel for a gun metal.

The addition of from 5 to 15 per cent. of aluminum to type-metal composed of 25 per cent. antimony and 75 per cent. lead makes sharper castings and more durable type.

To ordinary brass the addition of aluminum gives superior strength and better anti-corrosive qualities.

Aluminum has been successfully used to replace lithographic stone.

Powdered aluminum mixed with chlorate of potash is used to give a photographic flash-light, which gives much less smoke than the magnesium compounds used.

The Tacony Iron Metal Company, a well-known Philadelphia concern, has successfully produced an aluminum coating for iron, which undoubtedly will have considerable use in the future.

To the inventors who shall produce good methods of nickel, silver and gold-plating aluminum, so that it can take the place of German and nickel-silver, a rich reward is in waiting.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

(*Concluded from page 277.*)

We will not discuss the other cases that may occur, where the switches are trailing switches, as distinguished from the facing switches discussed, or turnouts from the outside of a curve, where the main track is to the left and the turnout to the right, with facing and trailing switches.

From what has been previously said, it will be readily seen that the frog angles remain the same, the only difference being in the way in which the frogs are curved.

It may readily be seen that the turnout does not necessarily curve in a different direction from that of the main track.

The length of the radius of the turnout may continue to increase till it reaches infinity, where the turnout curve becomes a tangent.

In this case the problems arising may be solved from the formulæ given for turnouts from tangents, by regarding the turnout as the main track, and the main track as the turnout.

Likewise the turnout may be from the outside of the curve, and the curve be in the same direction as that of the main track. Here it is evident that the radius of the turnout must be greater than that of the main track. If the two radii are equal, the curves must coincide, and there will be no turnout. If the radius of the turnout be less than that of the main track, the turnout must necessarily be from the inside of the curve. Where the turnout is from the outside of the curve and the turnout curve is in the same direction as the main track curve, we may, for the purpose of solving the problems that may arise, regard the main track as the turnout curve and the turnout as the main track, when the problems will be identical with those for the solution of turnouts from the inside of the curve.

From what has gone before, the Engineer will note that where the turnout is from a tangent, the frog angle is equal to the central angle. Thus, in fig. 4, the frog angle $D\,B\,E = B\,A\,C$.

Where the turnout is from the inside of a curve, the frog angle is equal to the difference between the two central angles. Thus, in fig. 11, the frog angle $B\,A\,C = K\,B\,A - B\,C\,A$.

Where the turnout is from the outside of a curve, the frog angle is equal to the sum of the two central angles. Thus, in fig. 19, the frog angle $D\,A\,E = A\,B\,G + A\,C\,F$.

To find the radius of the turnout curve R' from the outside of the curve, given the radius of the main track $= R$, the gauge $= g$, and the frog angle $D\,A\,E = B\,A\,N = K\,B\,A + H\,C\,A$, fig. 22.

In the triangle $A\,C\,B$, fig. 22,

$$AC+HC : AC-HC :: \text{tang.}\,\tfrac{1}{2}(AHC+HAC) : \text{tang.}\,\tfrac{1}{2}(AHC-HAC)$$

now $\quad A\,C = R + \frac{1}{2}g$

$\quad H\,C = R - \frac{1}{2}g.$

Hence $\quad A\,C + H\,C = 2\,R$

and $\quad A\,C - H\,C = g.$

Also $\quad A\,H\,C + H\,A\,C = 180° - H\,C\,A.$

The frog angle $D\,A\,E = B\,A\,N,$

and $\quad A\,H\,C = 180° - A\,H\,B = 180° - H\,A\,B.$

The angle

$$HAC = 180° - HAN = 180° - (HAB + BAN) = 180° - (HAB + DAE)$$

As above, the angle

$\quad A\,H\,C = 180° - H\,A\,B$

and $\quad H\,A\,C = 180° - (H\,A\,B + D\,A\,E)$

hence $\quad A\,H\,C - H\,A\,C = D\,A\,E.$

Substituting in above proportion,

$$2\,R : g :: \text{tang.}\,\tfrac{1}{2}\,(180° - H\,C\,A) : \text{tang.}\,\tfrac{1}{2}\,D\,A\,E.$$

Since the tang. $\frac{1}{2}\,(180° - H\,C\,A) =$ tang. $90° - \frac{1}{2}\,H\,C\,A$, substituting, we form the equation,

$$\textit{tang.}\ 90° - \tfrac{1}{2}\,H\,C\,A = \frac{2\,R \times \textit{tang.}\,\tfrac{1}{2}\,D\,A\,E}{g};$$

but, as before remarked, since the tangent of 90° minus a given angle is equal to the cotangent of the given angle, we have the equation,

$$\textit{cot.}\,\tfrac{1}{2}\,H\,C\,A = \frac{2\,R \times \textit{tang.}\,\tfrac{1}{2}\,D\,A\,E}{g}. \qquad (27)$$

Since $D\,A\,E = H\,C\,A + H\,B\,A$, to find $H\,B\,A = K\,B\,A$, we have $H\,B\,A = D\,A\,E - H\,C\,A$.

Example: Given the radius of the main track, $R = 2864.93$, the frog angle $D\,A\,E = 7°\ 09'\ 10''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the central angle $H\,C\,A$, fig. 22:

$2\,R = 5729.86$.	....	3.7581441
$\frac{1}{2}\,D\,A\,E = 3°\ 34'\ 35''$	............*tang.*	8.7958867
$g = 4.708$ ar. comp.	....	9.3271635
$\frac{1}{2}\,H\,C\,A = 0°\ 45'\ 11\frac{1}{2}''$	............*cot.*	1.8811943

whence $H\,C\,A = 1°\ 30'\ 23''$,
and $K\,B\,A = (7°\ 09'\ 10'') - (1°\ 30'\ 23'') = 5°\ 38'\ 47''$.

In the triangle $A\,C\,B$, fig. 22, we now have the angles and the side $A\,C = R + \frac{1}{2}g$, given to find the side $B\,A = R' + \frac{1}{2}g$.

From trigonometry,

$$R' + \tfrac{1}{2}g = \frac{R + \tfrac{1}{2}g \times \textit{sin.}\ H\,C\,A}{\textit{sin.}\ K\,B\,A}. \qquad (28)$$

Example: Given the radius of the main track, $R =$

2864.93, the frog angle $D\ A\ E = 7°\ 09'\ 10''$, the gauge $g = 4'\ .\ 8\frac{1}{2}'' = 4.708$, to find the radius R' of the turnout curve, fig. 22.

Having found from equation 27 the angle $H\ C\ A = 1°\ 30'\ 23''$, and deduced the angle $K\ B\ A = 5°\ 38'\ 47''$, we use equation 28 as follows:

$R + \frac{1}{2}g = 2867.284$	3.4574708
$H\ C\ A = 1°\ 30'\ 23''$ .... *sin.*	8.4197644
$K\ B\ A = 5°\ 38'\ 47''$ ar. comp..... *sin.*	1.0070550
$R' + \frac{1}{2}g = 766.11$	2.8842902

whence by subtracting the $\frac{1}{2}$ gauge $= 2.354$, the radius of the turnout R' is found to be 763.756.

THE CHORD DISTANCE.

Having as above found the radius of the turnout curve, the chord distance $H\ A$, fig. 22, may be readily found in a manner like that employed for turnouts from the inside of curves.

Thus in the right-angled triangle $M\ B\ A$, fig. 22, we have the three angles and the side $B\ A = R' + \frac{1}{2}g$ given to find the side $A\ M = M\ H = \frac{1}{2}\ A\ H$.

From trigonometry,

$$A\ M = (R' + \tfrac{1}{2}g) \times sin.\ M\ B\ A,$$

which equation is identical with equation 20 for the case there discussed.

To find the length of the arc $H\ A$ from the heel of the switch to point of frog, fig. 22. It is evident that this problem may be solved by an equation of the form of equation 8, substituting arc $A\ H$ for arc $B\ H$, the same equation answering whether the turnout is from a tangent or from the inside or the outside of a curve.

In conclusion, it may be well to say that practice does not require any iron-clad adherence to nice mathematical calculations. In some cases considerable labor may be saved by the use of the "rule of thumb" or "short-cut" rules in common vogue, especially in the case of turnouts from a tangent. Creditable work here, as in much other work of its class, requires common-sense judgment as to what is necessary and what is not.

Thus in putting in three-rail turnouts from a tangent, with the first frog No. 8 (gauge 4 ft. $8\frac{1}{2}$ in.) requiring a lead from head-block to frog-point of 52.9, I have found that this distance may be lengthened or shortened at least 2 ft., without in any visible manner affecting the appearance or usefulness of the turnout.

A bright foreman with a good eye for line will (with a little practice) readily put in these switches in a creditable manner, without any stakes being given by the engineer, provided only that he be furnished with frogs of the required angles properly curved.

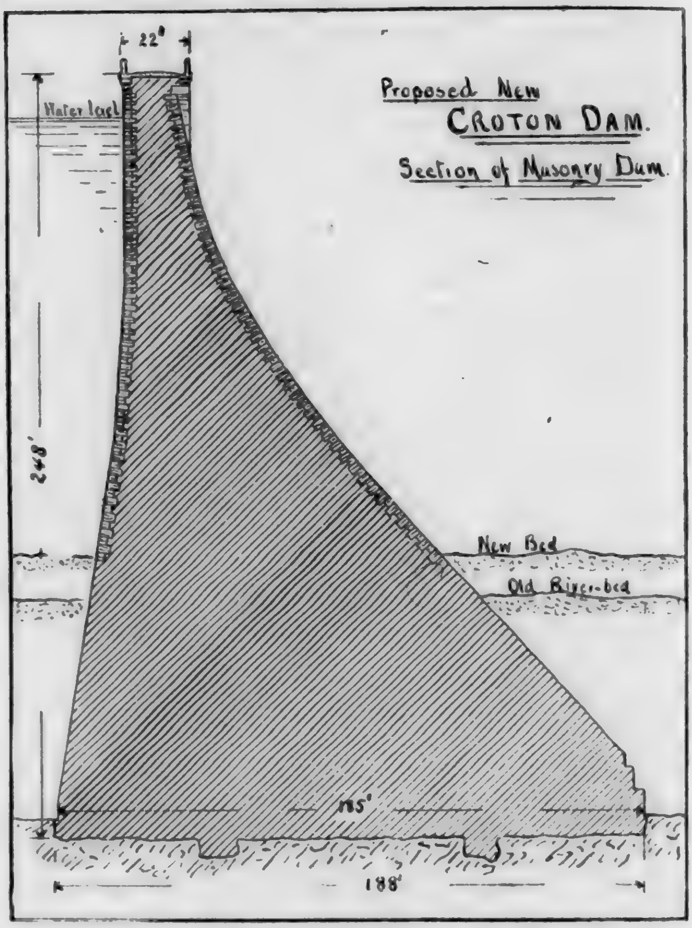
THE NEW CROTON DAM.

THE New York Aqueduct Commission has passed by the plans for the erection of the Quaker Bridge Dam, about which so much was said and written some time ago, and has decided upon the construction of a new dam on what is known as the Cornell site, which is one of those recommended by Chief Engineer Fteley. The grounds of this decision are that a dam at this place will cost much less than at Quaker Bridge, and can be built in a shorter time, while the storage capacity of the basin behind the dam will be nearly as great. It is estimated that the structure on the Cornell site can be completed, with all the auxiliary works, within seven years, and that the storage capacity of the basin will be about 30,000,000,000 gallons, which, with the storage reservoirs already constructed and to be constructed on the upper waters of the Croton and its branches, will give a secure supply sufficient for the needs of the city for several years to come. In other words, it is believed that with this dam and the storage provided, the full capacity of the Croton water-shed can be utilized, and that any further demand for water will have to be made by drawing from the water-shed of the Housatonic Valley. The latter, however, is so far in the future as not to require present consideration.

Acting upon this decision the Aqueduct Commissioners called for bids for the work on the new dam on May 17, the time set for receiving the bids being June 15.

The new dam will cross the Croton Valley some distance below the present or old Croton Dam, and will consist of three parts. The first part, beginning on the southern side of the valley, will consist of an earth dam with a masonry core. The core will be of rubble masonry in cement, with a foundation in the rock well below the river-bed, and will taper from 18 ft. at the foundation to 6 ft. at the top. The earth dam will be 30 ft. in width at the top, with slopes of 2 to 1, and will be faced on the up-stream side with 18 in. of broken stone and 2 ft. of stone pavement. It will extend for a little less than one-half the distance across the valley.

The second portion will be a masonry dam about 700 ft. in length extending across the deepest part of the valley. The height of this structure at the central part will be 248 ft. from the foundation to the coping, the foundation being in the bedrock some 80 ft. below the present bed of the river. It will vary in thickness from 185 ft. at the foundation to 22 ft. at the top, and will be of the section shown in the accompanying sketch. The main body of this dam will be composed of rubble stone masonry set in cement, the facing being of cut stone in Portland cement mortar. A roadway will be carried across the top and continued over the overflow by a bridge.



Near the northern bank of the stream this masonry dam will turn almost at right angles, and will be carried along parallel to the side of the valley, forming an overflow nearly 1,000 ft. long, making the total length of the masonry about 1,650 ft. The top of the overflow, by which the water level is determined, will be 14 ft. below the coping of the main dam.

Some idea of the extent of this work will be had from the statement that the estimated quantities include nearly 600,000 cub. yds. of earth excavation; 300,000 cub. yds. of rock excavation; 900,000 cub. yds. of earth embankment, and nearly 600,000 cub. yds. of masonry. A new channel is to be provided for the Croton River during the construction of the Dam.

THE ALMY TUBULOUS BOILER.

THE illustration herewith shows a compact form of water-tube boiler, which may be added to those tubulous boilers which have been described and illustrated in previous numbers of the JOURNAL. In those articles the peculiar advantages of this class of steam producers have been referred to, and it is only necessary here to describe the present one as a very good example of its class. The boiler shown was built for the torpedo-boat *Stiletto*; it has, with forced draft, furnished steam for a triple-expansion engine indicating from 550 to 600 H.P. It was built for the *Stiletto* by the Almy Water Tube Boiler Company, of Providence. In the engraving the casing is shown with a portion broken away so that the construction can be seen. The boiler has the following dimensions: Grate area, 29½ sq. ft.; heating surface, 1,090 sq. ft.; weight complete, with casing, 14,700 lbs.

The heating surface of this boiler is composed of 1-in. steel pipes which are disposed as shown, making their turns with bends and elbows connecting to four-way branch fittings, and these are connected by a union to flange nipple at top and bottom manifolds. There is a manifold in the form of a rectangle below the grates with a mud drum in center at the back cross-section which forms the base of each furnace. The top manifolds are four sections running parallel, connecting with an enlarged heater across the front. The elements which rise from back of boiler extend across at right angles to heating surface, forming the crown of fire-box. Between the vertical pipes which form middle wall of furnace is placed a wall of fire-brick, which completely

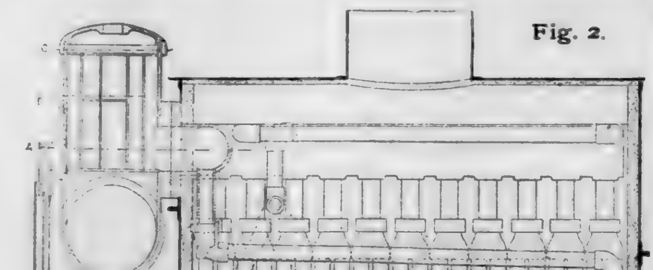
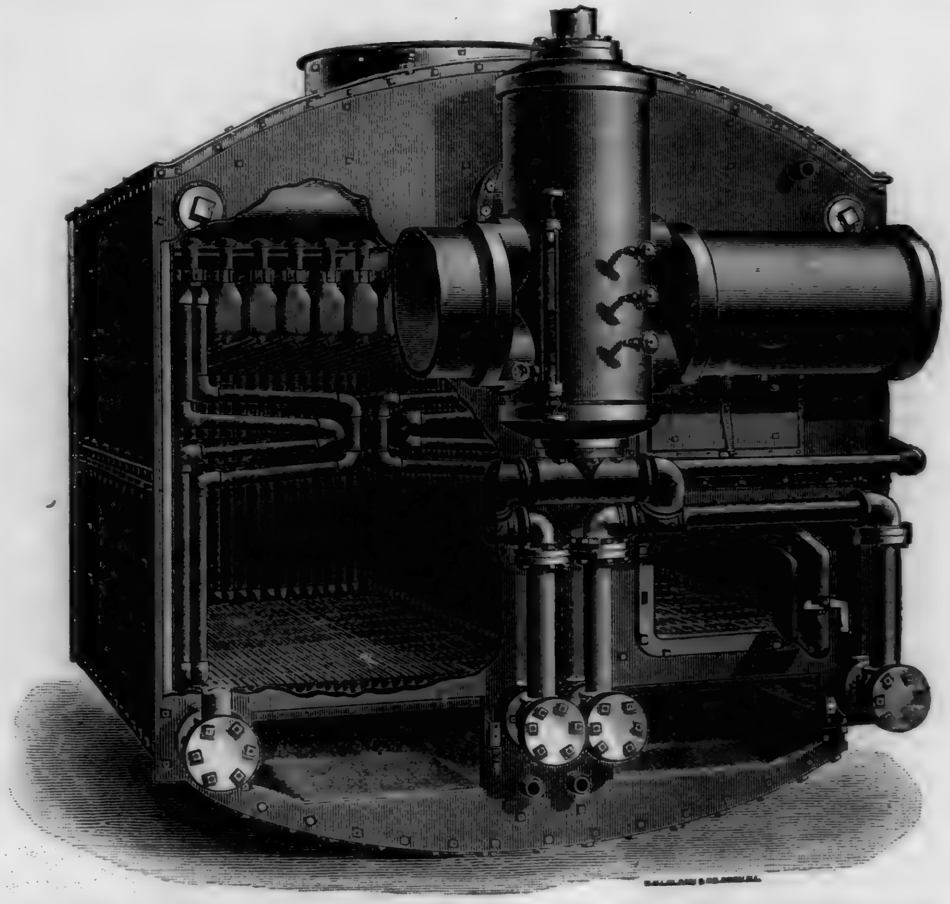


Fig. 2.

divides the two furnaces. Each of the elements which form the side and crown of the fire-box can be removed from the furnace without disturbing the casing, by simply removing the grates and unscrewing unions at top and bottom; the fore-and-aft section can be removed from the back.

There is ample room to get to the top end of all the elements from the back of the boiler by removing a small section of casing arranged for that purpose. The whole internal heating surface of the boiler may be removed and



replaced from the front, without taking down separator or disturbing the top manifold or casing, except the front sheet. The arrangement of heating surface is such that the gases, after leaving the furnace, have to pass at right angles to heating surface and through very narrow channels, which bring them in contact with the metal. Another point in this arrangement of heating surface is, that it is all water surface from the grate-line to the vertical nipples which connect to top of manifold. Each element is independent of the other, and can be stopped off or removed very easily, and the boiler can go on with its work with but a short interruption. It will be noticed that the fire-box walls are composed of double rows of tubes, which increases the heating surface relative to the weight and grate surface, besides making the circuit short and the pipes of smaller diameter, thus permitting the boiler to be driven very hard when occasion demands it.

The system of pipes when completed is cased in either sheet steel or iron, lined with asbestos, the fire-box being in addition lined in front with fire-brick. This casing is made in sections and bolted to angle-iron in such a way that any section may be readily removed, enabling repairs to be made without trouble.

The water is fed to the boiler in such a manner that it is subjected to the heat of the escaping gases just before they reach the flue, which, of course, conduces to economy and efficiency. Steam is taken through a separator which is placed in front, and which operates on the centrifugal principle for the separation of water from the steam, if there be any present. A jet of steam or hot water introduced through openings in the casing is used to clean soot or ashes from the pipes. Fig. 2 shows a longitudinal section of a marine boiler, showing more clearly the arrangement of the tubes.

This boiler is of the non-explosive class—that is, any failure is confined to a single element, and there can be

no general destruction of the boiler. Repairs can be made easily by taking out a weak or injured section and inserting a new one.

ON THE WAYS AT THE WHEELER YARD.

This boiler has in a high degree the advantages of its class, the capacity to raise steam quickly and to stand very high pressures and the economy in space and weight. There can be no question that for many kinds of service these will much more than counterbalance the disadvantages charged to the type in the small volume of water carried, and the necessity for care in feeding and firing to obtain good results, especially in continuous work. In the boiler under consideration much of this objection is met by the arrangement of the steam-drum and the method of feeding, which makes the circulation complete and continuous. It has done excellent service, both in marine and stationary work.

A LAKE SHIP-YARD.

ONE of the largest ship-yards on the great lakes, which may be considered a typical lake yard, is the establishment of F. W. Wheeler & Company, at Bay City, Mich. Here both wooden and steel vessels are built, and a great variety of work is done. A view recently taken of the steel plant shows four large vessels on the stocks, although several have lately been launched, and a short account of the work done there will be interesting.

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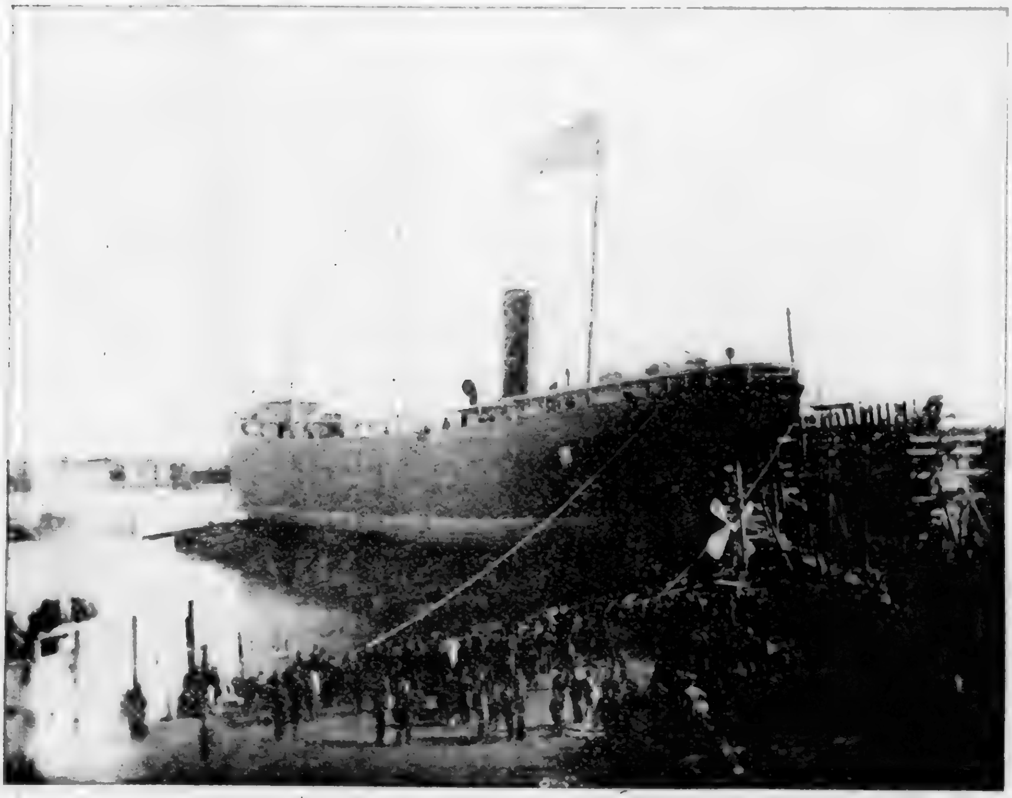

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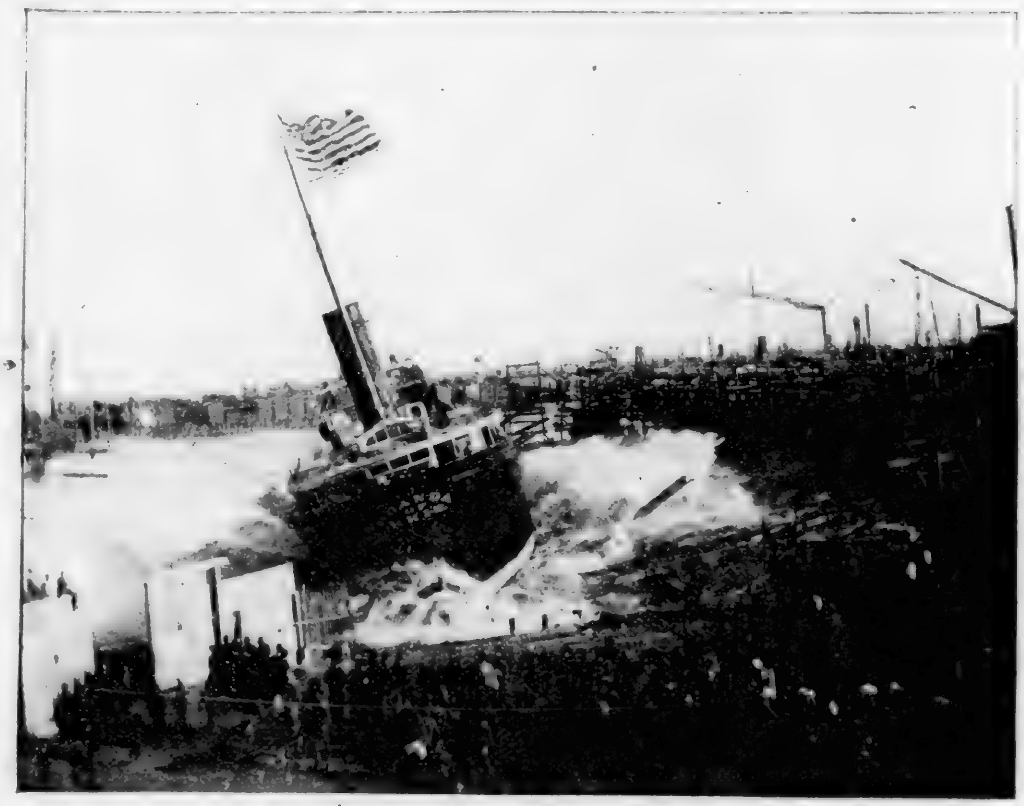

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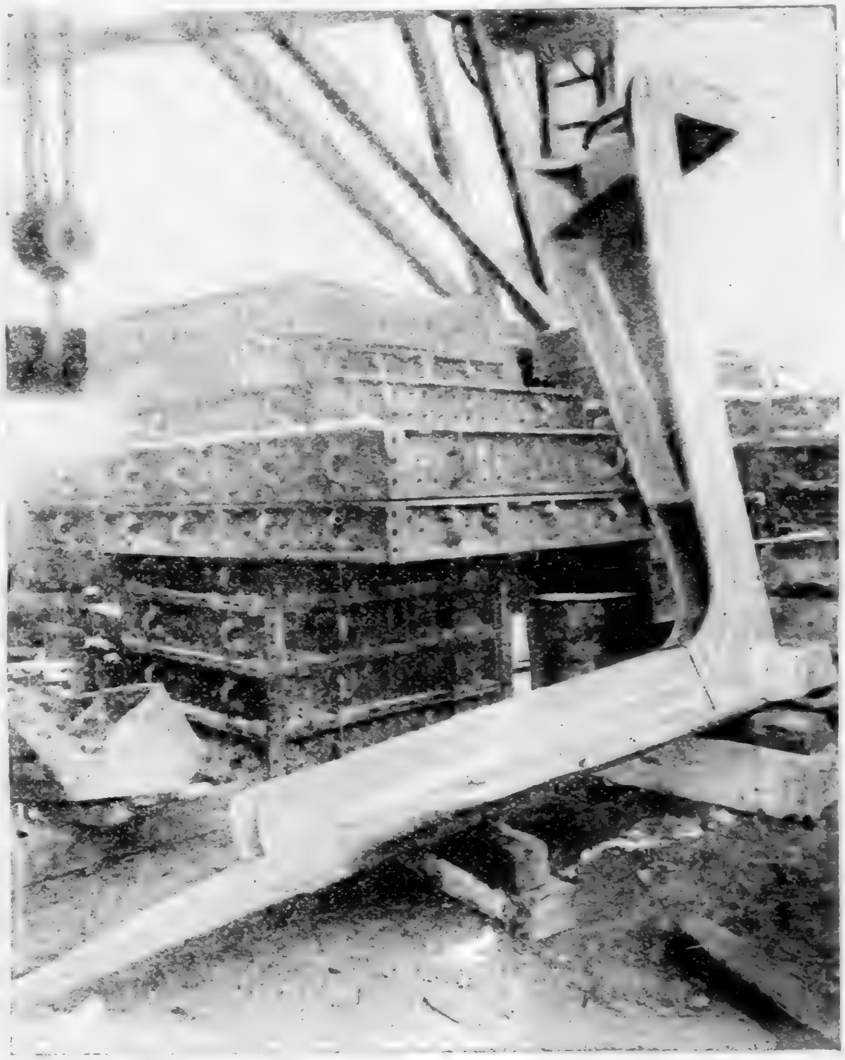

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LOCOMOTIVE RETURNS FOR THE MONTH OF MARCH, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	61	54	51,931	77,5[illegible]	36,893	166,324	3,080	....	....	57.93	101.01	45.98	76.04	...	6.33	4.90	5.40	0.24	0.50	6.10	2.00	19.14	....	....	....
Alabama & Vicksburg	18	14	17,778	14,422	9,831	42,031	3,002	....	....	50.38	112.35	48.19	72.73	....	6.34	3.30	6.50	0.30	1.00	5.90	1.80	18.80	....	....	....
Atchison, Topeka & Santa Fé	818	721	....	....	315,581	2,000,776	2,775	....	....	...	....	....	83.44	....	....	5.77	6.90	0.28	0.16	6.32	1.82	21.25	....	...	1.58
Canadian Pacific	591	...	490,419	877,417	275,102	1,642,938	2,780	...	....	....	....	...	74.80	....	...	4.07	13.11	0.44	....	5.44	1.36	24.42	....	2.07	3.41
Chic., Burlington & Quincy	504	....	....	....	....	1,774,928	3,522	5.33	17.54	....	....	....	89.76	....	....	4.74	6.46	0.23	0.36	7.01	....	18.80	...	...	1.41
Chic., Milwaukee & St. Paul	804	....	....	......	....	2,247,328	2,795	....	....	...	....	....	78.06	....	.	5.08	7.84	0.28	....	6.97	....	20.17	....	....	1.95
Chicago & Northwestern	846	....	667,175	1,335,642	607,759	2,610,576	3,086	....	....	....	....	....	89.73	....	...	3.72	8.20	0.36	....	6.26	0.86	19.40	....	....	1.81
Cincinnati Southern	106	100	80,840	172,374	73,640	326,854	3,269	...	...	70.92	125.00	42.28	92.59	....	7.54	3.80	6.10	0.27	0.50	6.60	1.70	18.97	....	....	...
Cleve., Cinn., Chic. & St. L.	....	463	453,672	674,830	371,483	1,444,985	3,239	4.20	20.50	75.27	118.55	74.30	94.47	17.92	5.63	3.39	6.08	0.17	1.83	6.38	0.25	18.10	...	....	1.28
Cumberland & Penn.	....	22	4,674	25,601	....	30,275	1,376	....	....	....	....	....	100.00	...	...	[illegible]	5.40	0.40	...	....	2.30	16.10	....	....	....
D., L. & W., Morris & Essex Div.	156	...	167,038	254,228	12,039	433,305	2,778	....	....	...	....	....	65.66	....	....	4.70	10.25	0.34	....	5.95	....	21.24	....	....	3.08
Hannibal & St. Joseph	42	40	49,991	75,625	24,691	150,307	3,757	4.81	16.04	....	...	....	87.41	17.89	6.46	3.78	5.70	0.15	0.27	6.52	...	16.42	....	....	1.40
Kan. City, F. S. & Mem.	152	....	105,170	245,981	113,904	465,055	3,059	....	....	...	....	....	67.66	....	...	3.16	5.87	0.21	0.44	7.31	....	16.99	....	....	1.68
Kan. City, Mem. & Birm.	41	38	36,192	56,021	10,879	103,092	2,713	...	....	....	....	....	67.43	....	....	3.17	4.04	0.80	....	6.93	....	14.94	....	....	1.15
Kan. City, St. Jo. & Council Bluffs	44	41	59,024	46,058	39,831	144,913	3,537	4.86	20.74	....	...	....	67.29	14.35	4.59	5.11	5.32	0.12	0.16	6.08	....	16.79	....	....	1.89
Lake Shore & Mich. South	576	....	441,508	870,364	584,622	1,896,494	3,292	....	....	63.47	90.83	35.71	67.68	....	....	3.11	5.43	0.18	....	6.94	0.19	15.85	....	....	1.59
Louisville & Nashville	....	*344	435,332	813,525	383,233	1,642,090	3,663	5.04	15.83	64.10	112.45	48.23	83.93	12.79	6.86	5.00	6.78	0.26	1.42	6.11	0.64	20.21	3.41	1.54	1.62
Manhattan Elevated	....	290	788,514	....	66,967	855,481	2,950	..	....	....	....	....	46.62	....	....	2.80	9.40	0.30	....	8.70	....	21.20	....	...	4.03
Mexican Central†	146	119	....	....	....	368,917	3,100	....	...	...	....	....	66.35	....	....	5.53	16.55	0.41	0.16	5.88	0.95	29.48	....	....	5.60
Mil., L. S. & West	112	99	78,633	169,285	81,875	329,793	3,311	....	....	....	....	....	88.30	....	....	3.55	13.20	0.25	....	6.31	0.83	24.17	....	....	3.00
Missouri Pacific	339	310	....	....	....	1,133,033	3,654	4.31	17.15	....	....	....	96.24	19.02	6.92	5.46	6.51	0.33	1.38	6.44	1.46	21.58	4.52	1.45	2.28
N. O. & Northeastern	36	28	27,400	43,163	20,655	91,218	3,258	....	....	58.82	108.11	36.10	77.82	....	6.10	3.70	7.20	0.27	0.70	6.20	1.50	19.57	....	...	....
N. Y., Lake Erie & West	....	622	445,495	1,025,893	297,114	1,768,502	2,846	4.50	20.50	93.90	136.60	73.80	....	21.10	6.60	3.87	7.42	0.40	2.20	7.17	1.11	22.17	....	1.70	1.29
N. Y., Pennsylvania & Ohio	...	261	146,709	462,740	140,061	750,410	2,875	5.00	17.40	68.20	128.10	72.90	...	13.60	7.40	3.99	6.73	0.31	2.06	6.68	0.99	20.76	...	1.77	1.25
N. Y., Prov. & Boston	....	92	101,018	48,772	55,023	204,813	2,226	....	...	....	...	....	53.28	....	....	3.09	10.61	0.51	....	6.41	0.93	21.55	....	....	....
Norfolk & Western, Gen. Eastern Div.	....	131	98,792	232,745	69,418	400,955	3,061	4.30	19.30	...	....	....	102.04	....	....	6.80	4.20	0.80	....	....	....	11.80	....	....	....
Durham Division	....	6	7,182	10,146	1,710	19,038	3,173	5.50	3.40	....	....	....	60.61	...	....	1.90	8.50	0.40	....	....	....	11.80	....	....	....
Radford Division	....	52	16,492	114,255	9,191	139,938	2,691	5.10	17.10	....	....	....	137.93	....	...	10.20	5.60	0.80	...	...	....	16.60	....	....	....
Pulaski Division	....	27	27,171	48,731	7,599	83,501	2,783	4.70	11.90	....	....	....	105.82	....	....	5.60	4.30	0.70	....	....	....	10.60	...	....	...
Clinch Valley Division	....	41	20,750	56,497	17,539	94,786	2,312	3.70	10.10	....	....	....	125.78	....	....	10.50	5.20	1.10	....	...	....	16.80	...	....	....
Ohio & Mississippi	113	....	137,179	171,316	95,273	403,768	3,573	..	....	....	....	....	69.91	....	....	3.43	3.13	0.22	1.62	5.46	1.45	15.31	....	....	0.88
Old Colony	....	210	316,839	130,011	112,927	559,777	2,666	....	....	....	....	....	61.84	....	....	3.44	11.59	0.66	....	6.90	0.81	23.40	....	....	3.75
Philadelphia & Reading	....	....	452,711	824,044	551,384	1,828,139	....	....	....	....	....	....	89.97	....	...	4.85	5.04	0.30	....	5.76	0.40	16.35	...	...	....
South. Pacific, Pacific Sys.	....	701	....	....	....	1,587,405	2,264	....	....	....	....	....	67.18	...	....	5.90	18.47	0.36	1.68	7.29	1.90	35.60	...	....	5.67
Vicksburg, S. & P.	24	14	16,848	9,072	11,000	36,920	2,637	....	....	49.63	85.84	20.55	53.19	....	6.87	5.10	7.00	0.24	0.80	6.20	2.40	21.74	....	....	....
Wabash	393	347	406,688	707,610	251,031	1,365,329	3,915	4.85	18.27	68.98	109.47	57.00	....	14.49	6.05	3.12	5.27	0.29	....	6.18	0.85	15.71	2.82	0.97	1.20
Wisconsin Central	153	137	127,105	279,457	65,404	471,966	3,445	...	...	..	....	....	88.69	....	....	3.69	10.35	0.24	....	7.24	....	21.52	....	....	2.28

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 16.3 units of work per $1 of expense; 169.2 units of work per ton of coal; 11.2 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

Bending Rolls for Heavy Plates.

THE accompanying engraving shows a very heavy and powerful machine for bending plates, built by the Niles Tool Works at Hamilton, O. The machine is complete in itself, two upright two-cylinder reversing engines being placed on the bed-plate for driving the rolls and for raising and lowering them.

This machine has four rolls—two central rolls, one placed above the other, and two side rolls moving in inclines on either side, adjustable to suit the diameter to be bent.

The rolls are all solid wrought-iron forgings. The center rolls are 26 in. diameter, the side rolls 22 in. diameter. The center rolls are driven by a pair of reversing engines, running them in either direction. The side rolls are raised and lowered by an independent reversing engine. These rolls may be operated together or separately, or either end of either roll may be raised independently, as may be required.

The housings supporting the rolls are very strong and substantial. The journal bearings of the rolls are of very large diameter and fitted into bearings set into the housings.

The entire machine is mounted on a very heavy sole-plate provided with anchor-bolt holes to secure it to the foundation.

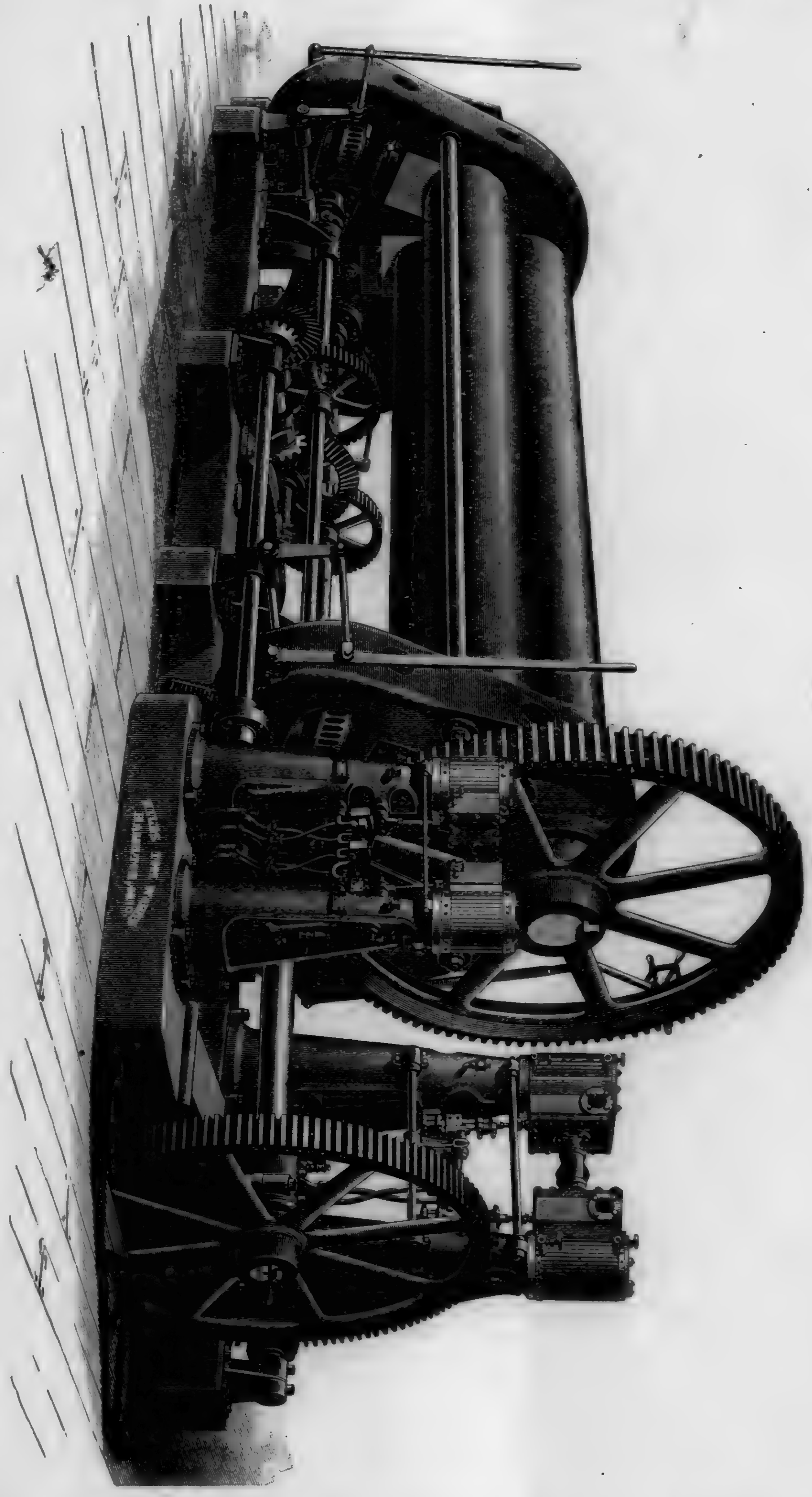
The machine will bend ship plates, curving them in any manner required, and has ample power and strength to do the work expeditiously.

A machine constructed in this manner, with four rolls, curves the sheet almost up to the edge, leaving only a short straight end. This is specially important when working heavy plates such as the machine will bend.

The machine is intended to be set in a pit, upon a solid foundation. All reversing and operating levers, etc., are brought above the floor line, which should be about the height of the cross-girt.

The machine shown in the cut—which is called by the makers No. 10—will bend plates up to 1¼ in. thick and 16 to 22 ft. long. Two of them were recently built for the United States Government, and are now in use at the Norfolk Navy Yard, bending heavy plates.

The Niles Tool Works have also built a machine almost exactly similar in design, but somewhat larger and heavier, for the Mare Island Navy Yard in California. This machine—called No. 12—has four rolls 22 ft. 6 in. long, and will bend plates up to 2 in. in thickness; the rolls have an adjustment of 20 in. The main gear of this No. 12 machine is 10 ft. diameter and 15 in. face, the teeth having 5 in. pitch. The driving engine has two 12 × 16-in. cylinders, and the whole weight is 250 tons.



NO. 10 POWER BENDING ROLLS, BUILT BY THE NILES TOOL WORKS.

THE Baldwin Locomotive Works, Philadelphia, are building 10 heavy passenger locomotives for high speed on the Baltimore & Ohio Railroad. Another recent order is for 10 consolidation and 5 ten-wheel engines for the Norfolk & Western.

THE Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., has recently received orders for its patent stay-bolts from the Michigan Central, the Delaware & Hudson Canal Company, the Long Island and the Manhattan Elevated Railroads.

The Baker Submarine Boat.

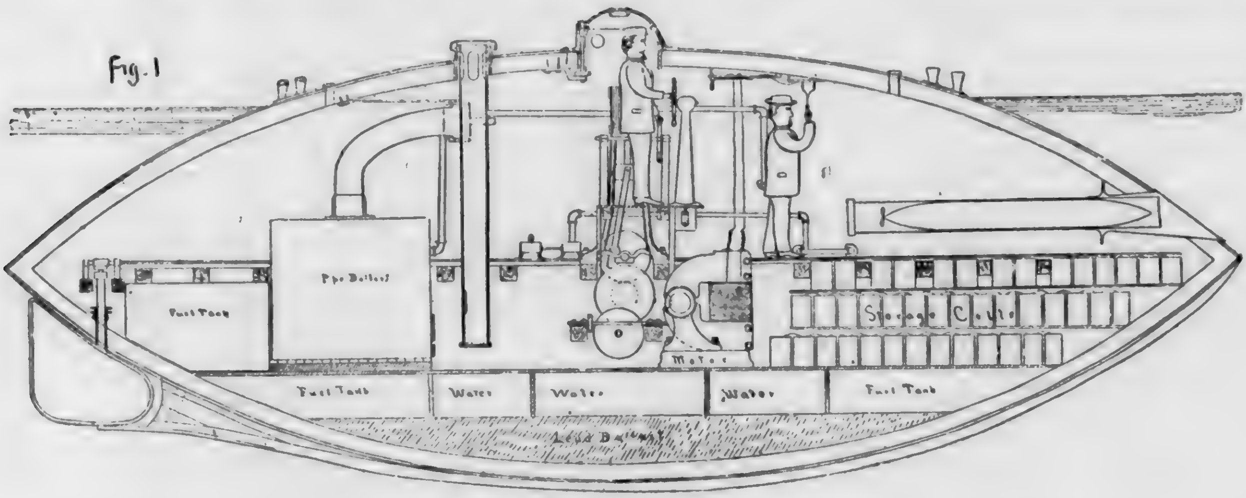
THE accompanying illustrations, from the Cleveland *Marine Journal*, show a submarine torpedo-boat devised by Mr. George C. Baker, of Des Moines, Ia. This gentleman has made a study of the subject for several years, and about a year ago ordered an experimental boat built by F. P. Ballin, of Detroit, Mich. This boat is shown in the cuts, fig. 1 being a section and fig. 2 a small sketch showing the general appearance of the boat under water.

The construction of a hull to withstand the pressure at a depth

of 80 or 100 ft. was no easy problem, but it was solved by using 3-in. oak plank 6 in. wide sawed in cylindrical form, so that a number of pieces joined together made a frame, the frames diminishing in size from the center frame being bolted together so as to form the spheroidal hull. The longitudinal sections are parabolic and the cross sections ellipses. This hull was covered with canvas and then longitudinally planked with 2-in. plank. The dimensions of the hull are 40 ft. over all, 9 ft. beam and 14 ft. deep, from top of conning-tower to bottom of hull being 16 ft. There are five water-tight compartments 2 ft. deep between the deck and the ballast hold, but two of them can be used for oil tanks if desired. The boat is self-contained, and needs no shore connections to drive it. The driving power is in duplicate, an electric plant and a steam plant, the former for running under water and the latter for surface propulsion, the steam plant being so arranged that it can be used to generate electricity for charging the storage batteries. This boat is believed to have the largest storage battery plant in the world. It consists of 236 Woodward cells of 700 ampere hours' capacity, installed by Mr. H. H. Humphrey, of Detroit. They and the boat answers to it readily. It will be understood by the foregoing description that such a boat would have no difficulty in running at the surface, but the following description of a descent will explain its submarine capabilities. The boat has about 75 tons displacement, the hull weighing 20 tons, the ballast 30 tons, the storage battery cells 10 tons, engine and boiler and gearing 8 tons, and motor 3 tons, leaving 4 tons buoyancy. The normal draft of the boat leaves about 2 ft. of the crown of the hull above water. The pilot and electrical engineer enter through a man-hole in the conning-tower, and the cover is drawn over and fastened when the boat is air-tight. If it is considered that the hull contains 1,500 cub. ft. of air, a sufficient supply for two men for 18 hours, the possibility of suffocation is removed.

The pump is started and two or three tons of water pumped into the water bottoms, this additional weight leaving nothing of the boat above the surface except the top of the hull and the conning-tower. To sink directly downward the wheels are turned perpendicular to the shaft and the motor started. The amount of spare buoyancy determines the amount of power

Fig. 1



THE BAKER SUBMARINE BOAT.

are divided into two parts and are worked in multiple. The cells are connected with a 50-H.P. Jenny motor, which is thrown in gear with the main shaft when it is desired to sink the boat and run under water. The steam plant consists of a 4½ × 5½ ft.

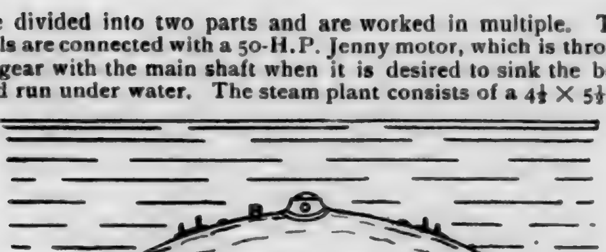


Fig. 2.

Roberts' water-tube boiler, which has a patent telescopic stack. This stack is lowered and the stack-hole covered when fire is not required. The boiler is fed by a Worthington pump. The 7 × 7-in. Willard engine can be thrown in gear with the main shaft, and it can also be belted to the motor, which is turned into a dynamo by changing brushes and reversing the connections when it is desired to re-charge the storage battery.

There is nothing astonishing about this means of propulsion, but the success of the boat lies in the propeller wheels, the arrangement, connection and manipulation of which have been patented by the inventor. There are two 24 in. propeller wheels, one on either side, connected with one shaft amidships. To the ends of the shaft are attached gear wheels, working in the gear attached to propellers, which are turned in any position by means of a sleeve around the shaft. This sleeve is connected to a hand-wheel with chain belting. By means of this hand-wheel the propellers may be placed in any position. The propellers are protected by brackets from coming in contact with any obstruction. The rudder fits close to the hull necessary to sink the boat. When the desired depth is attained then the propeller wheels are turned at an angle of about 45°, and the boat is propelled forward, neither rising nor sinking. To ascend to the surface the machinery is stopped, and the reserve buoyancy causes the boat to rise. Any accident that would stop the machinery would also cause the boat to ascend. The storage batteries will run the boat three hours at a speed of eight miles an hour.

This boat has been repeatedly worked in the river Rouge, near Detroit, both on and under the surface, in water from 15 to 20 ft. deep; this has been done to test the working of the machinery and become familiar with the action of the boat.

More recently a test was made in the Detroit River with a depth of about 40 ft., a strong current and many boats passing, making it a very difficult place to operate such a craft.

The conning-tower was closed over the two occupants, Mr. Baker and his assistant, at 1.50 P.M., and remained closed until 4.35, in all 2 hours 45 minutes, in which time no unpleasant atmospheric effect was noticed. When the boat was opened the air seemed as fresh and invigorating as when at first closed. During this trial the boat was repeatedly submerged, disappearing entirely from sight and leaving no disturbance on the surface to note the location of the submerged craft. The boat retained its even keel beneath the surface and answered readily in rising and lowering to the requirements of the pilot. Altogether, the tests so far have been very satisfactory and will be continued from time to time until the full capacity of the boat is developed.

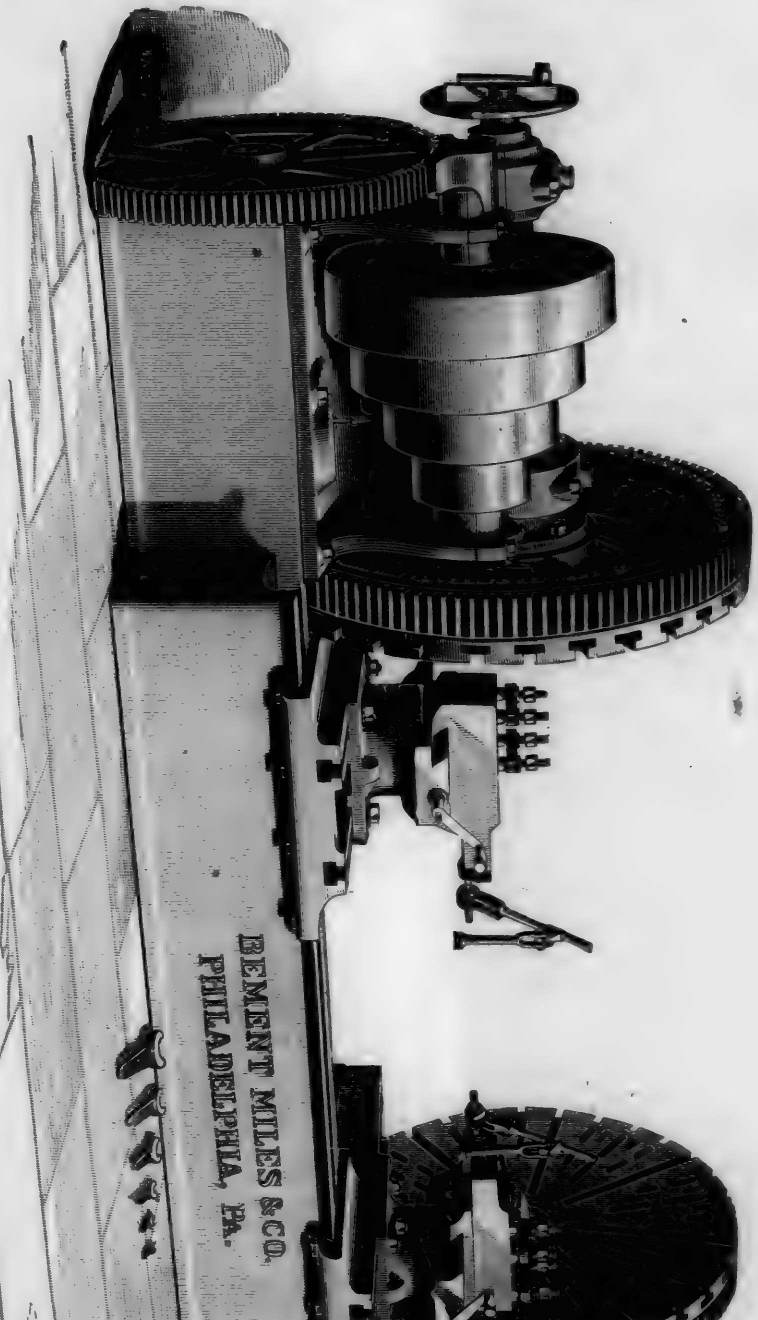
Some New Machine Tools.

The Philadelphia shops have for many years been noted for the excellent design and workmanship of their machine tools, and examples of their work can be found all over the country. The illustration given herewith shows a new tool from the works of Bement, Miles & Company, which are prominent in that city for the number and variety of the tools which they make.

The illustration shows a double-wheel lathe which will take in wheels up to 57 in. in diameter. The general construction will be readily understood from the engraving. The driv-

ing cone is so geared as to give eight changes of speed to one face-plate and four to the other. The face-plates can be driven together or separately, and at the same or different speeds, as desired. The feeds are variable and self-acting at all angles by an overhead rock shaft, actuated by slotted cranks at the end of the spindles. Each main spindle has an internal sliding spindle, with sufficient movement beyond the face-plates to swing driving-wheels on axles when the crank-pins are in place. The center line of the spindles is carried backward, so as to bring the cutting strains on the greatest diameters within the area of the bed; by this means the front slides are elevated to correspond with the curvature of the face-plates, increasing the strength of the bed where it is subject to the greatest strength. By this also the tool-rests are shortened, and are therefore stiffer. The advantages will be appreciated by those who have had occasion to use lathes of this class.

These tools are, it is hardly necessary to say, made and finished with the care which is shown with all work turned out from these shops.



DOUBLE WHEEL LATHE BY BEMENT, MILES & COMPANY, PHILADELPHIA.

The Arrowhead Dam.

In a pamphlet recently read before the Engineers' Club of Cincinnati, Colonel Latham Anderson described a dam about to be built by the Arrowhead Reservoir Company at Little Bear Valley, Cal.; the object is to store the waters of the Mohave River to irrigate a large district near San Bernardino.

On account of the configuration of the valleys very short dams will be required, extending between the steep rock slopes of the cañon, on either side. The granite of which these slopes are composed forms excellent material for masonry, but the soil in the neighborhood does not afford material suitable for puddle; also, on account of the frequency of earthquakes in this part of the continent, it was considered unsafe to rely on a purely masonry dam.

To meet all the conditions, the following type of dam has been proposed by the writer: The water face of the dam to have a face of masonry on a slope of $\frac{1}{2}$ to 1 of a uniform thickness, to act as a retaining wall when the reservoir is empty. The thickness calculated for a dam 150 ft. high is 10 ft. This masonry is to have a dry backing 2 ft. thick, with the joints well filled with cement mortar 3 or 4 in. from the lower face. A tile underdrain is extended along the bottom of this wall with outlets under and across the dam, and discharging below its foot atregular in tervals of height. The dry wall thus acts as a drain to the masonry above it. This composite wall rests upon an earthen dam. Instead of being spread in layers in either of the usual methods, the earth, granite bowlders and gravel are piped into place by the hydraulic method. The wall is first carried up as high as it can be safely built on this slope without support. When a section of the wall is finished to this height the earth backing is filled in to within a few inches of the top of the wall. Another section of the wall is then built and another layer of earth filling piped in; this process being carried on to as high a level as it is practicable to pipe in the earth. It is expected to be possible to construct the dam in this manner to a height of 125 or 150 ft., above which level the earth filling will be made of the same material as below, but in one of the usual manners, probably with wire rope and trolleys. The lower slope will be kept in shape by dry stone facing carried up as the piping proceeds.

With water convenient, under a good working head, the earth can be filled in at from 4 to 5 cents per cubic yard. The upper portion, to be filled in by cable, will probably cost from 20 to 25 cents.

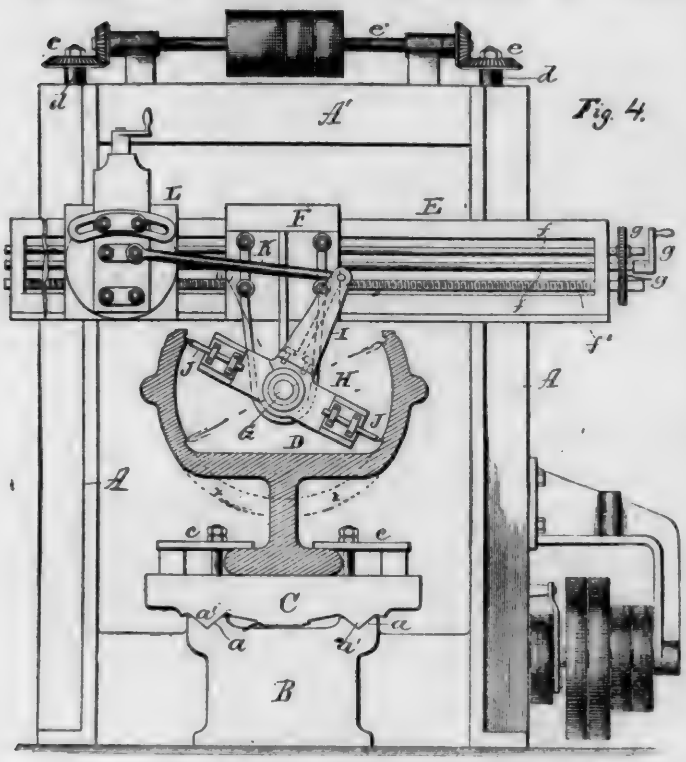
The wall is to be of concrete filled in with large blocks of granite, the joints in no case being less than 2 in. thick. The facing, 10 ft. thick, is to be of large blocks of granite rubble laid in cement mortar with $\frac{3}{4}$-in. joints. The material, including blocks of granite weighing four to five tons each, is to be distributed on the wall by wire rope and trolley.

The cañon has bare rock walls so nearly vertical that the dam is only 50 ft. long on the bottom and less than 200 ft. at the height of 125 ft. The thickness of the dam on the bottom is over 90 ft. It has a slightly arched form in plan. Its total height is to be 150 ft. The upper 25 ft. traverses a long granite ridge after leaving the cañon. The plans, it is understood, are shortly to be carried out and the dam built.

Recent Patents.

MACHINE FOR PLANING CIRCULAR GUIDES FOR ENGINE BEDS.

THE engraving, fig. 4, represents a device for the purpose described in the title, which has been patented by Mr. Herman



HABERLIN'S PLANER FOR CIRCULAR GUIDES.

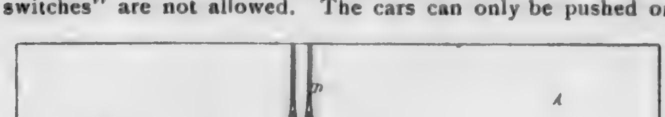
Haberlin, of Akron, O. The illustration makes the construction sufficiently clear without any further description.

RAILROAD PUZZLE.

THE "new and useful improvement in puzzles," illustrated by fig. 6, has been patented by Mr. J. C. Jackson, of Greenville, Pa.

The problem presented is to place the locomotive and cars as shown, run the locomotive around the Y to reverse it, and leave the cars as they were found—3 at *F*, 2 at *B*, and 1 at *C*.

In the solution of the problem what is known as "running switches" are not allowed. The cars can only be pushed or



JACKSON'S RAILROAD PUZZLE.

pulled by the locomotive. Neither can but one car or the locomotive alone be upon the spur *D* at one time. Neither can more than two cars or the locomotive and one car be upon the main track at the left of the Y, as at *E'*, at one time. The main track between the branches of the Y will hold the locomotive and one car.

The inventor's solution of his puzzle will be withheld until the August number of the JOURNAL appears.

An Electric Freight Railroad.—The Farmington & Doe Run Railroad is a short line now under construction from De Lassus Station, on the Belmont Branch of the St. Louis, Iron Mountain & Southern to the town of Farmington, Mo. It is 4½ miles long and is laid with 52-lb. rails. It is to be operated by electricity, both passenger and freight cars being furnished with electric motors.

Manufactures.

General Notes.

THE E. P. Allis Company, in Milwaukee, is making the engine which will furnish the motive power for nearly all the machinery at the Exposition. This engine will be one of the largest ever built; it is of the quadruple-expansion type, and is expected to work up to about 3,500 H.P. The engine will constitute the chief part of the Allis Company's exhibit.

THE Chicago Ship-building Company has taken a contract for a large steel steamer for Buffalo parties. The vessel is to be 287 ft. long, 41 ft. beam and 24 ft. 6 in. depth of hold. The engine will be built by Trout, in Buffalo; it will be a triple-expansion, with cylinders 19 in., 33 in. and 52 in. in diameter and 45 in. stroke.

THE Wellman Iron & Steel Company now has in operation at its mills in Thurlow, Pa., the largest plate rolls in this country. The mill can turn out plates 126 in. in diameter and 70 ft. long. The rolls are 132 in. long, the top and bottom rolls being 34½ in. in diameter and the middle roll 20 in. The engine driving the train is a Wetherill Corliss, with cylinder 40 × 60 in., and a fly-wheel 25 ft. in diameter. The table rollers are driven direct by a double horizontal engine made by the Crane Company, of Chicago. This mill has many improvements; it was designed by Mr. S. T. Wellman and built by the Garrison Foundry Company, of Pittsburgh. The heating furnaces were also designed by Mr. Wellman.

IT is stated that the stock of the Pratt & Whitney Company, of Hartford, Conn., which is so well known as a manufacturer of tools and of gauges and other instruments of precision, has been sold to an English syndicate. The capital stock is $600,000, and the dividends last year amounted to 15 per cent. Besides its regular tool business, the Company has contracts for making the Hotchkiss and the Gardner rapid fire guns, and has made a great deal of gun-making machinery.

A LARGE addition is being erected to the assembling and erecting shop of the Westinghouse Machine Company, in Pittsburgh. The structure is of brick, 50 × 265 ft., and displaces the old erecting shop which was 30 × 265 ft., and in which nearly 5,000 engines were built and tested. The new shop will be 30 ft. high inside and well lighted by means of 3,000 square feet of skylight, and will be equipped with two 10-ton power cranes. Additional boiler capacity of 250 H.P Babcock & Wilcox boilers is being erected to be equipped with Roney stokers. The Company's business has outgrown the old capacity and the additions are undertaken to provide for an increased number and larger sizes, designs being now under way for 1,000 H.P. engines. April sales of Westinghouse engines amounted to 3,185 H.P., and those for May to nearly the same amount.

THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently brought out a new milling machine for heavy work, which is called No. 8. This machine takes up a floor space of 114½ × 68½ in., and weighs about 5,000 lbs. The table is heavy, 66 in. long, 16 in. wide, having a working surface 54 in. long and a bearing in saddle 40 in. in length. It has three T-slots running the entire length between the pans at end of same. It may be lowered 19½ in. below the center of spindle, and has an automatic feed of 48 in. and an adjustment in line with spindle, of 9⅞ in. Milling may be done 21 in. from face of column, and cutters 16 in. diameter may be used. The cone has three steps (the largest 13¾ in. diameter) for 4½-in. belt. The back gearing is 8½ to 1, thus giving, with the two speeds provided on countershaft, 12 speeds for spindle. The feed cones have two steps, and by transposing these and changing the feed gears, eight changes of feed from 0.02 in. to 0.25 in. to one revolution of spindle may be obtained in either direction. The overhanging arm is of steel 4¾ in. diameter, and may be rigidly connected to the knee by an improved arm brace, which is readily adjustable and has a bearing for the outer end of arbor, thus allowing the usual arbor support to be used at any intermediate point near the cutter to counteract the tendency of the arbor to spring under heavy cuts. The vise has jaws 7½ in. wide, 1¾ in. deep, and will open 4½ in. The machine is adapted for a wide range of work.

THE Union Dry Dock Company, Buffalo, N. Y., recently launched the steamer *Codorus* for the Anchor Line. The new steamer's dimensions are as follows: Length over all, 290 ft.; length of keel, 275 ft.; beam, 40 ft.; molded depth, 26 ft. Two steel boilers of the Scotch type, each 12 ft. in diameter and 14 ft. long, built by the Lake Erie Boiler Works will supply power at 160 lbs. pressure, to a triple-expansion engine of H. G.

Trout's make, with cylinders of 20½, 33 and 54 in. in diameter, with 45 in. stroke. H. G. Trout also made the propeller wheel, which is 12½ ft. in diameter with 17½ ft. pitch. The *Codorus* will carry 3,000 tons on a draft of 15½ ft., and is expected to make 13 miles an hour with a full load.

THE American Steam Barge Company has, it is understood, made arrangements with an English company—William Johnston & Company, Limited—for the building of "whalebacks" for the Atlantic trade. The Cleveland *Marine Review* says of this arrangement: "Capitalists in the Barge Company here, chief among whom are John D. Rockefeller, Colgate Hoyt, and Joseph H. Colby, will, of course, be interested in the English company, but as yet the plans have not matured sufficiently to warrant very much being said of its success. The Johnston Line has a weekly boat from London to Boston, and from both Liverpool and London to Baltimore the service is also weekly. Close business relations with the Baltimore & Ohio Railroad is a feature of the Company's success in this country. Its business is not confined to boats running from Baltimore and Boston, but extends to all principal ports in Canada, Nova Scotia, and New Brunswick and to the Black Sea. The Company is one of the leading shipping concerns in England, and if the barges can be adapted to ocean service, the American owners of the patents have undoubtedly formed a sound connection abroad. It is intended to build oil-tank barges of the whaleback type for the Black Sea trade.

"Captain Alexander McDougall is now at Everett, the new barge town on Puget Sound, where two steamers are under way. It is very probable that marked changes will be made in the bows of the steamers for the Pacific Coast trade, as it has been shown in the case of the *Wetmore* that the present form of bow is a weak part of the vessel, especially when running light, and additional water ballast space forward will hardly remedy this defect."

THE annual meeting of the Consolidated Car-Heating Company was held at Albany, N. Y., June 6. The affairs of the Company were found to be in a prosperous condition, with excellent outlook for future business. A semi-annual dividend of 1½ per cent. was declared, payable August 15, transfer books to close August 1. Vice-President William C. Rice reported sales had averaged over $1,000 for every working day of past year. This included product of Canadian factory at Coaticook, P. Q. The Sewall steam coupler and improved (McElroy) commingler were reported as being used by many leading railroads of the country, having a mileage of 45,071 miles and 11,204 passenger cars. During the year 16,471 of these couplers have been sold. Officers were chosen as follows: President, Robert C. Pruyn, Albany; Vice-President and Treasurer, William G. Rice, Albany; Secretary, Charles J. Peabody, South Orange, N. J.; General Manager, Daniel D. Sewall, New York; Mechanical Superintendent, James F. McElroy, Albany; Assistant General Manager, James H. Sewall, Chicago. The following is the Board of Directors: Robert C. Pruyn, William G. Rice, Charles J. Peabody, D. D. Sewall, James F. McElroy, James H. Sewall, George Westinghouse, Jr., R. C. Blackall, H. A. Osgood, Albion Little, Charles Tracey, C. A. Jackson, George L. Walker, A. S. Hatch, and Anthony N. Brady.

After the election a visit was paid to the large new factory of the Company just completed in Albany.

THE Schenectady Locomotive Works have nearly completed an order for 27 engines for the Southern Pacific Company. All of these are two-cylinder compounds; seven of them are ten-wheel engines for passenger service, and the other 20 are twelve-wheel engines for freight service on the Mountain Division.

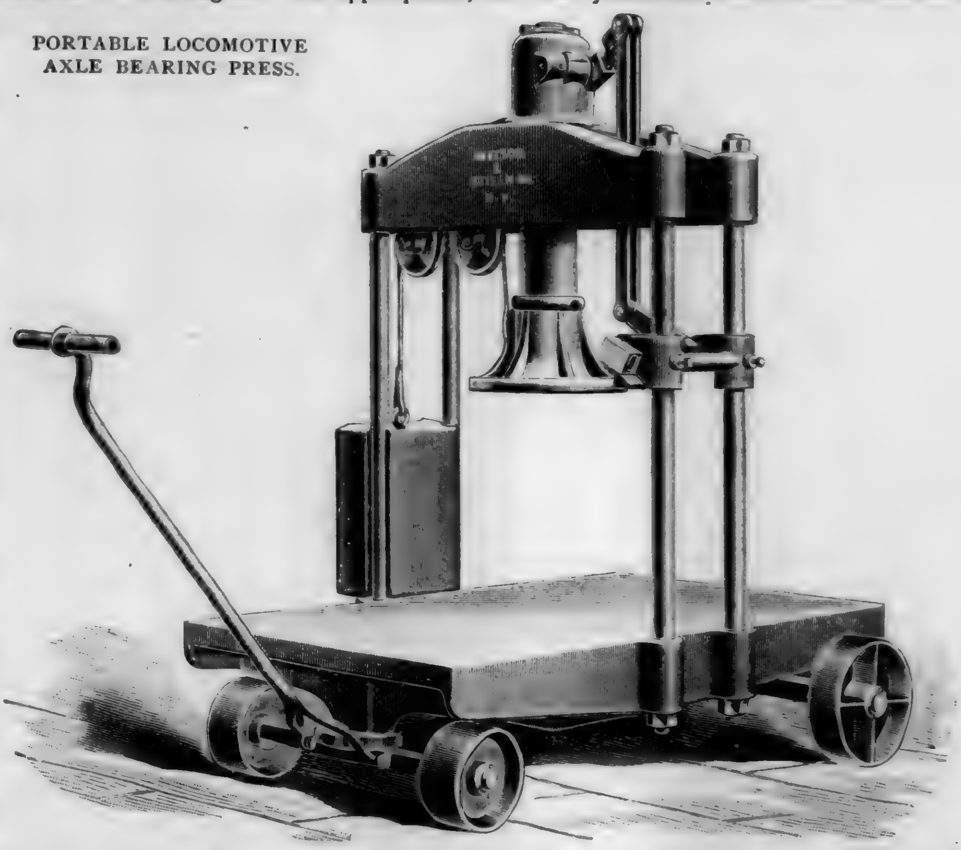
THE Cooke Locomotive Works, Paterson, N. J., are building six passenger engines with 19 × 24 in. cylinders for the Delaware, Lackawanna & Western; three passenger engines with 18 × 24-in. cylinders for the Evansville & Terre Haute; one passenger engine with 18 × 24-in. cylinders for the Lehigh & Hudson. They have just completed an order for 22 ten-wheel engines with 19 × 24-in. cylinders for the Houston & Texas Central.

A Portable Axle Bearing Press.

THE cut herewith shows a new style of press intended to be used for forcing the brasses in and out of the boxes of locomotive axle bearings and similar work. The operating power is a 20-ton base style hydraulic jack of special make, mounted in the upper platen, with the cylinder and base counterbalanced; and as the operating lever in a regular jack would be too high for convenient manipulation, a special jack is used and a new device is attached to the rods, and at this position the jack is operated the same as it would be at the jack proper. The movement is 12 in., and the full opening between the lower platen and the bars is regularly 18 in. The lower platen is made 30 × 48 in., and has a hole 4 in. in diameter through its center for forcing work through it when the plug which fills it is removed. The counterweight is so situated that it is not in the way, and is held in place when moving the press around the shop. The truck wheels are 7 and 10 in. in diameter by 3 in. face in the press shown, but any size of platen, height or power, can be made to order.

Patents have been applied for on this tool, which is made by the firm of Watson & Stillman in New York.

PORTABLE LOCOMOTIVE AXLE BEARING PRESS.



Some Uses of Graphite.

A CORRESPONDENT of the *American Machinist* says: "If engineers, machinists and millwrights in general, and pipe-fitters in particular, knew of the good qualities of graphite, I dare say there would be ten times the demand for it. Its lubricating qualities are questioned only by the impractical; and it is this quality alone that sounds its key-note, so to speak. Let me describe a few of what I consider its most important uses. As above stated, its primary object is lubrication, and it is to this fact we must credit good pipe joints and cool bearings. In making pipe cement (or, as I would term it, pipe smear), it is not necessary to use the best oil or grease, as it is the graphite and not the body in which it is suspended that makes the mixture valuable and the joint perfect. I use the drippings from line shaft bearings caught in the ordinary way, and mix it with the best Ticonderoga flake graphite, so that it can be applied with an ordinary sash tool.

"During the past three years I have used about 15 or 20 pounds of dry Ticonderoga flake graphite for pipe joints, cylinder heads, piston rod packing, etc.

"Bolts smeared with graphite mixed as above, I have unscrewed after having been in the dampest places for upward of two years or more, proving the anti-rusting qualities of graphite. To cool hot bearings, put it on as thick as it will mix with oil.

"Almost any oil or grease will answer, but don't use poor graphite."

A New Injector.

THE drawings given herewith show a new pattern of injector introduced by the Nathan Manufacturing Company of New York, and called by the makers the "Nathan" injector. It was intended to be an improvement on both the lifting and non-lifting instruments now in use, combining the best qualities of each. It is a self-contained instrument, comprising within itself the steam and water valves necessary for stopping, starting and regulating, and on a locomotive must be placed so that operating-rods can be carried into the cab.

A modified type is also made with detached starting and water valves, which will be found convenient in some cases, although the other type is considered preferable.

This injector must be placed below the lowest level of the water in the tank, so that the water will flow to it, but, unlike other injectors so placed, it is provided with a priming jet, and —this being a particular and novel feature, protected by patent —the overflow is placed above the highest water level in the tank, convenient to the engineer in the same manner as in a lifting injector, connecting with the overflow space in the injector body by means of a single piping, which can be applied and located in any convenient manner.

The advantages of the improvements made in this new pattern of injector can be appreciated from a careful study of the engravings. It may be added that it can be graded 50 per cent., making it suitable for light as well as for heavy work.

THE NEW "NATHAN" INJECTOR.

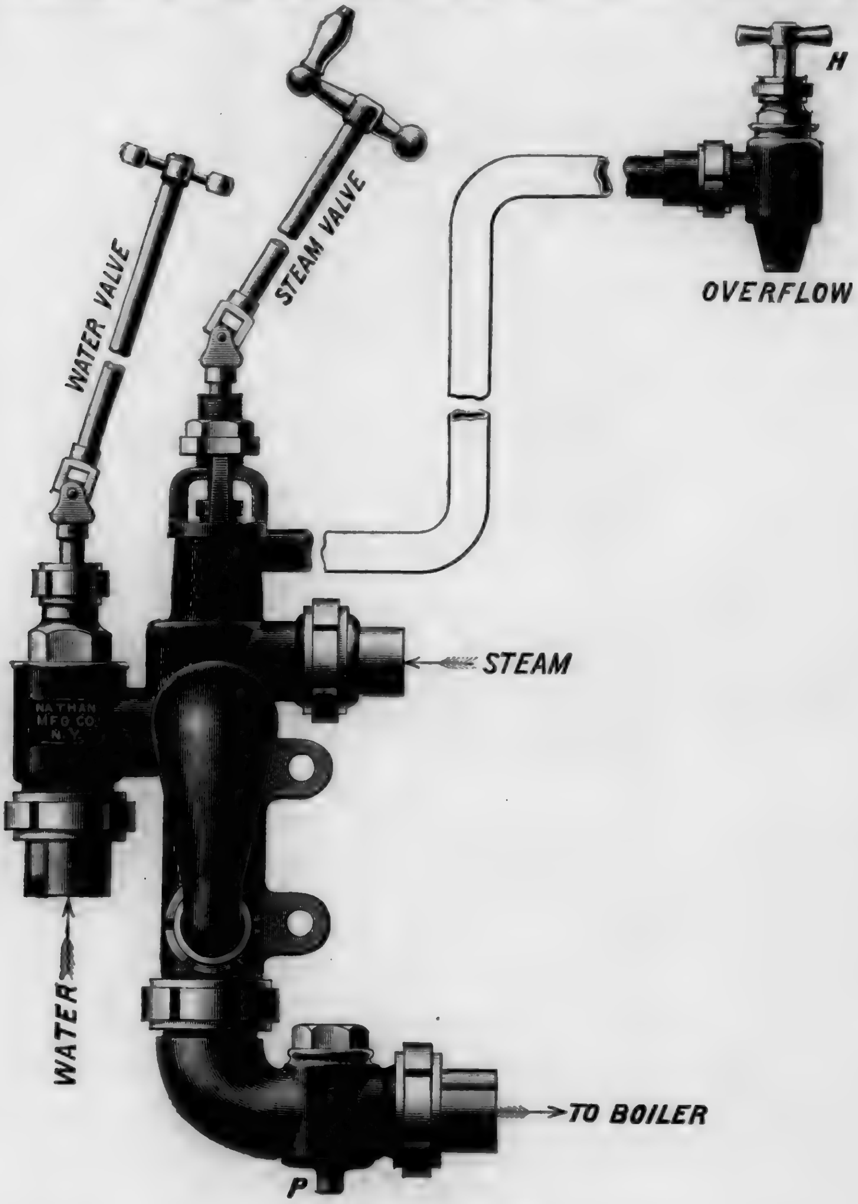


FIG. 1.—FRONT VIEW.

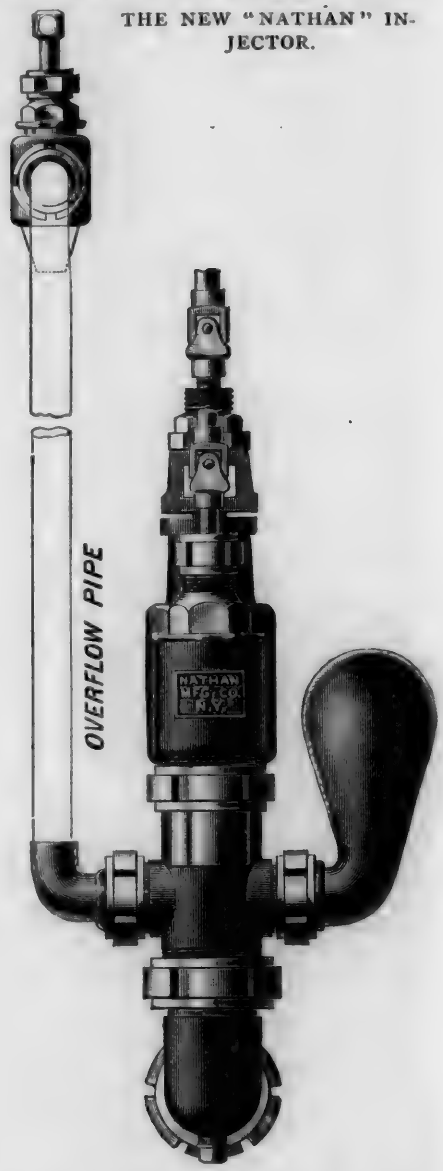


FIG. 2.—SIDE VIEW, SHOWING OVERFLOW PIPE.

A New Grate.

THE drawings herewith show a form of grate with which very good results have been obtained in stationary boilers; fig. 1 shows a boiler fitted with the grate, and fig. 2 shows a grate ready to go into the boiler. The illustrations show the construction so fully that little description is needed.

It will be seen that it is in effect a combination of a water-grate with a shaking grate, the object being to combine the advantages of both forms. The water-tubes run longitudinally, connections being made at the ends. The connections between the grate tubes and the boiler are shown in fig. 1; by these a constant circulation is kept up through the water-tubes, which are thus prevented from burning out, and also serve as an efficient heater for the feed-water. The shaking-bars placed between the water-tubes are worked by the levers placed in front of the ash-pit, and serve to clean the fire. When they are properly used a good fire can be kept up with but little trouble, even with inferior coal.

This grate has been under the test of actual use under a number of stationary boilers for a considerable time. The results have been very favorable, engineers who have used it reporting that it works very well, permitting the use of slack and other cheap grades of coal; less labor is needed to keep

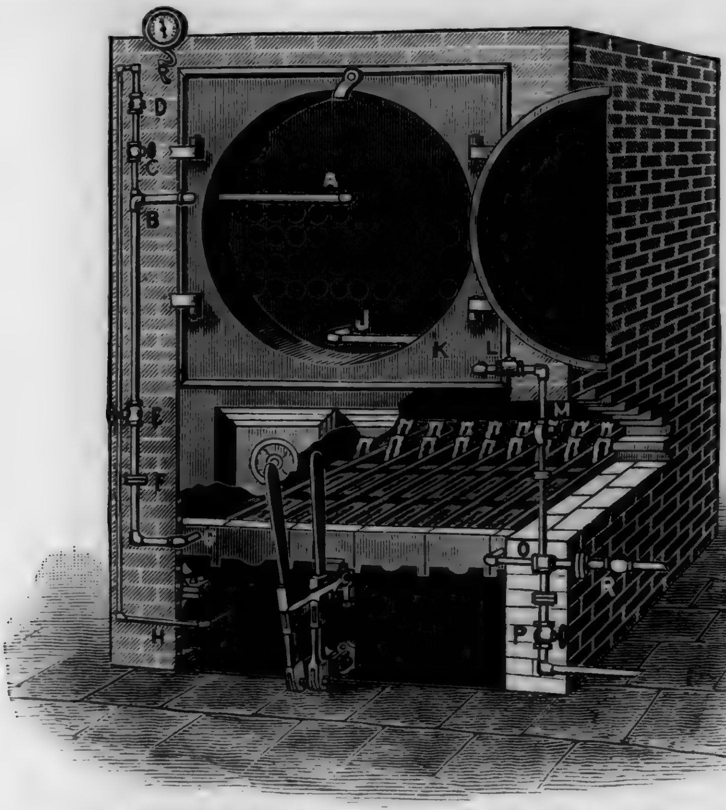


Fig. 1.

REAGAN'S WATER-CIRCULATING AND SHAKING GRATE.

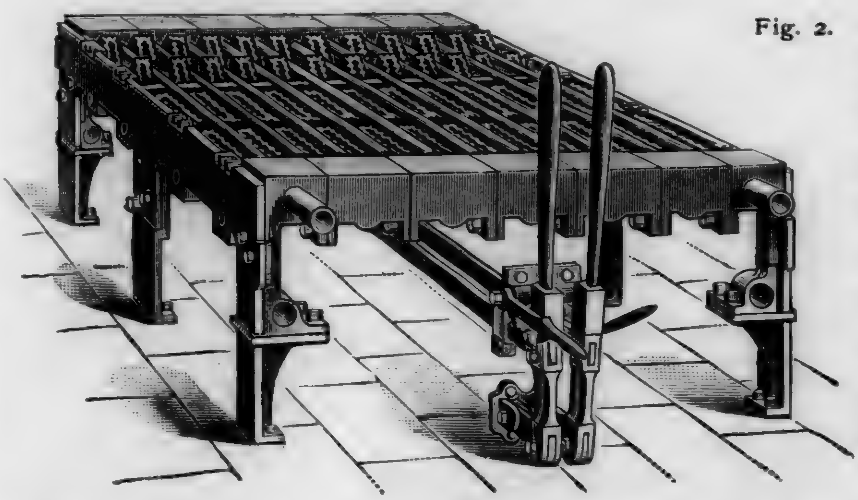


Fig. 2.

fires clean; no repairs are needed, and there is little or no deposit or scale.

The advantages claimed will be readily appreciated. This grate is made by James Reagan & Company, of Philadelphia.

The Allen Indicator Card.

THE accompanying diagram shows a new and very convenient indicator card for the use of engineers. The diagram is reduced in size, the card being actually $7\frac{1}{2} \times 4$ in.; the illustration shows so well the method of use that but little description is needed.

The card is made to take the place of the ordinary plain card, and is provided with a scale and machine divided perpendicular lines or ordinates. The scale on the left-hand side of the card is arranged to suit any pressure spring, and consequently there is no need of any scales other than that on the card.

The directions for working are: "After diagram is taken on card, take all perpendicular lines or ordinates within diagram. Measure with dividers on scale and place result opposite each line, as shown on illustration. Add the total number of ordinates taken, multiply result by scale of spring in hundredths—as scale 16 = 0.16, scale 32 = 0.32. Multiply result by 2; answer = effective pressure of steam on piston."

These cards are published by the firm of Williamson & Cassedy in Philadelphia.

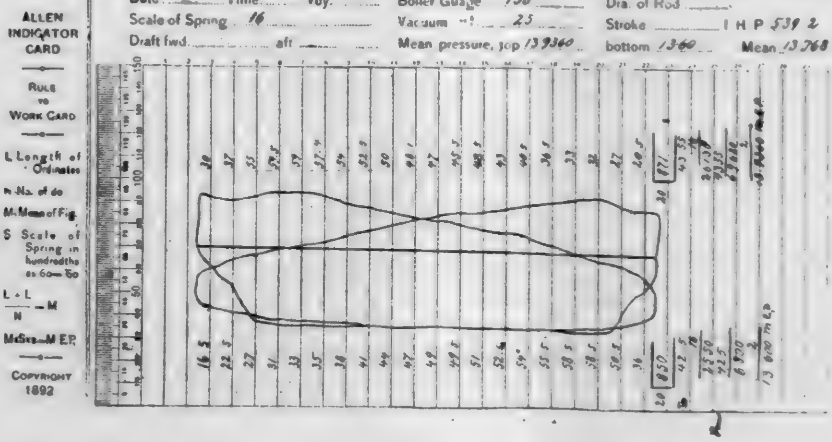
Baltimore Notes.

ONE set of engineers are surveying a line for the Baltimore & Cumberland Railroad from Cumberland down to Hagerstown, and another set has started from Hagerstown up to meet them. They are running what is called the water line. The interior or mountain line was carefully surveyed last year, and it is believed a better grade can be obtained along the water line. The new survey will probably be completed early in July. President T. B. Kennedy, of the Cumberland Valley Road, which runs from Winchester, Va., northeast to Harrisburg, Pa., was in Baltimore yesterday consulting with President Davis, of the West Virginia Central & Pittsburgh and the Baltimore & Cumberland, to discuss the question of making connection for his line with the new road at Hagerstown.

THE Baltimore & Ohio Company is preparing for extensive improvements on Staten Island to facilitate the freight business that will center there. The improvements that have just begun will take two or three years to complete, and will cost about $1,500,000. The developments in contemplation are the construction of new ferry slips and stations from the rapid transit trains running along the north and south shores from St. George. An immense new freight yard is to be established capable of accommodating 1,500 cars, with about 25 tracks running into it. The present ferry slips at St. George will be torn down to be replaced by two covered freight piers 500 ft. in length. The piers will be used for storing and handling freight. The docks will accommodate the largest ocean steamers, and vessels can be discharged directly into the cars. The company owns a large water front on Staten Island, and these improvements are but the beginning of extensive facilities that will be needed to meet growing demands.

THE Cleveland & Western Railroad, which is about 20 miles long, and runs from Worcester to Lodi, on the Chicago & Akron Branch of the Baltimore & Ohio, has passed into the ownership of the Baltimore & Ohio.

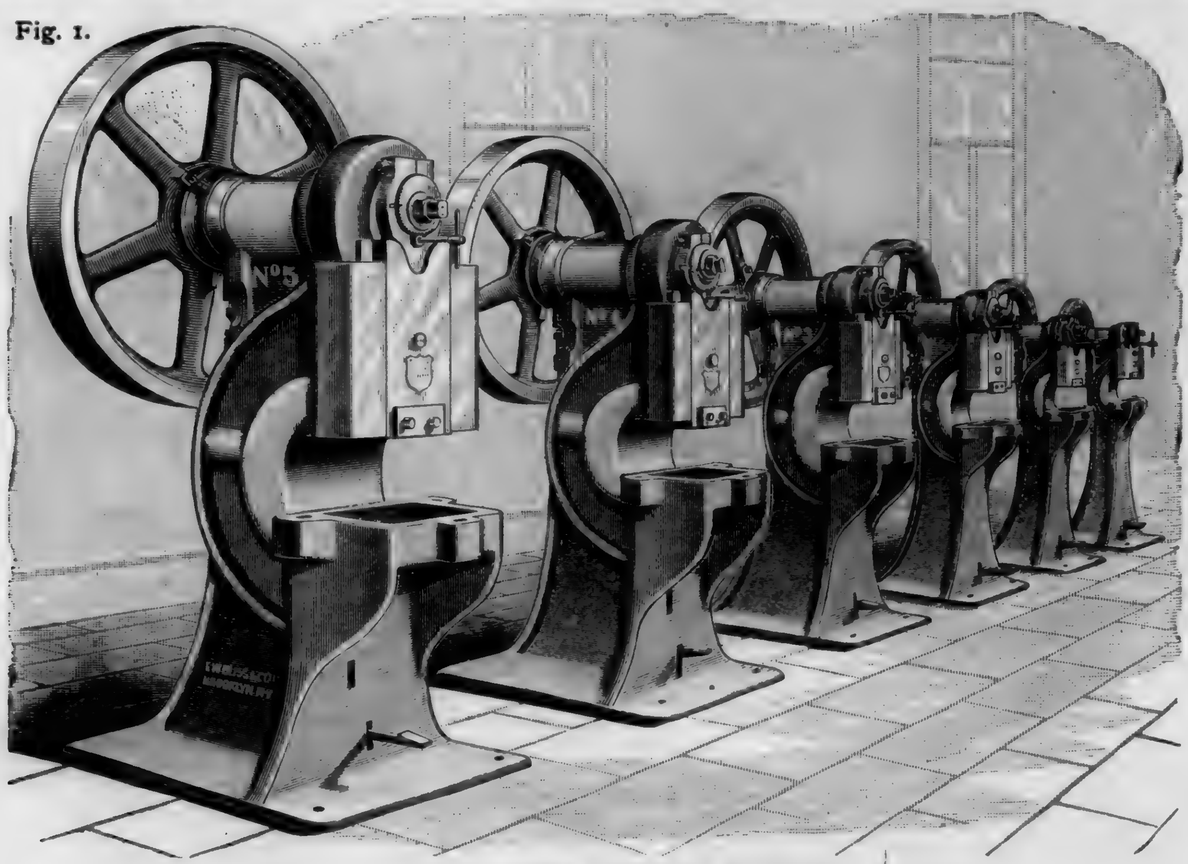
THE Universal Automatic Lubricator Company has been reorganized under the name of the Automatic Lubricator Company; the office is at No. 18 Broadway, New York, and Mr. John A. Wyman is Superintendent. The lubricator pad is now in regular use on all the locomotives of the New York, New Haven & Hartford, and on a number of other railroads; it is being tried on many roads also.



The Stiles Power Punching Presses.

THE illustration given herewith shows a group of the Stiles punching presses of six different sizes, from No. 5, the largest, down to No. 0, the smallest made. These presses are now

Fig. 1.



STILES POWER PUNCHING PRESSES.

Fig. 2.

made from new patterns, and with some new features recently introduced.

The eccentric adjustment used will be understood from fig. 2. It permits a rapid and very accurate adjustment, and transmits the pressure entirely through solid metal, instead of throwing upon screw threads, an advantage which will be appreciated. The graduation on the face enables the operator to keep an exact record of the setting of the dies.

The range of work for which these presses are adapted covers nearly every kind of blank-cutting, punching, perforating, forming and bending, including a large proportion of the operations needed in the manufacture of articles out of sheet metal, which now form such an important part of the work on many classes of machines.

These presses are made by the E. W. Bliss Company, of Brooklyn, N. Y., and have met with much favor, a large number being in use.

PERSONALS.

GEORGE BAILEY has been appointed Superintendent of Water Works at Albany, N. Y.

L. S. THORNE has been appointed General Superintendent of the Texas & Pacific Railroad.

MAJOR S. B. WATHEN has been appointed Resident Engineer of the Texas & Pacific Railroad

P. H. BAERMANN has been appointed City Engineer of Troy, N. Y., in place of C. L. FULLER, resigned.

R. H. BETHEL, formerly of New York, has been appointed Engineer of the Chicago Terminal Commission.

A. W. GIBBS has resigned his position as Superintendent of Motive Power of the Central Railroad of Georgia.

THOMAS C. CLARKE is the Engineer appointed to prepare the plans and supervise the construction of the new bridge over the Harlem River at Third Avenue, in New York City.

J. J. ANDERSON, for some time past in charge of the Macon shops, has been appointed General Master Mechanic of the Central Railroad of Georgia, with office in Savannah.

W. H. BRYAN, who for some time past has been with the Pond Engineering Company, has left that company and established an office of his own in the Turner Building in St. Louis.

M. E. WALLACE, for some time past Mechanical Engineer of the Gould Coupler Company, has been appointed Chief Draftsman at the Aurora shops of the Chicago, Burlington & Quincy Railroad.

C. H. Platt has been appointed General Superintendent of the New York, New Haven & Hartford Railroad. He has been for some time General Manager of the Grand Central Station in New York.

Joseph H. Franklin, late Station-master, succeeds Mr. C. H. Platt as General Manager of the Grand Central Station in New York. His jurisdiction includes the road to Mott Haven Junction and the Mott Haven yards.

Samuel Rea has been appointed Assistant to the President of the Pennsylvania Railroad Company. He is a well-known civil engineer, and has been at different times connected with the Pennsylvania itself and with other important lines. For some time past he has been a resident of Pittsburgh.

Thomas Urquhart, who has for a number of years been Superintendent of Motive Power of the Grazi-Tsaritzin Railroad in Russia, has been appointed General Manager of the great Nevski Works, in St. Petersburg, which manufacture locomotives and machinery of all kinds. Mr. Urquhart is well known as a frequent contributor to technical journals; he has also conducted many interesting experiments with locomotives.

On account of the development of his private practice as Consulting Bridge Engineer, J. A. L. Waddell, of Kansas City, Mo., has resigned the western agency of the Phœnix Bridge Company and the Phœnix Iron Company, which agencies he has held since January 1, 1887. His resignation takes effect July 1. A. C. Stites, who has been Mr. Waddell's principal assistant for four years, will take the agencies of the two companies, with headquarters at 121 Laclede Building, St. Louis. Mr. Stites will also take charge of a branch engineering office for Mr. Waddell, whose main office will still be at Kansas City.

E. M. Herr, recently Master Mechanic in charge of the West Milwaukee shops of the Chicago, Milwaukee & St. Paul, has been appointed Superintendent of the new Grant Locomotive Works in Chicago. He has an excellent reputation as a shop manager, and has had much experience. His staff includes some very good men; among them, as Chief Draftsman, R. Ryan, recently of the Chicago, Burlington & Quincy shops at Aurora; as Foreman of the machine and erecting shops, Peter Arnot, who was in the old Grant Works at Paterson, and who is a most capable mechanic and foreman; and as Foreman Blacksmith, G. Case, also of the old Paterson shops, and a man of much experience in his department.

OBITUARIES.

L. W. Towne, who died in Kansas City, Mo., May 14, was at one time an engineer on the Chicago, Burlington & Quincy Railroad, and later was made Master Mechanic of the Quincy Division of the same road. In 1866 he was appointed Master Mechanic of the Hannibal & St. Joseph Railroad, and afterward became Assistant General Superintendent. He was later General Superintendent of the Atchison & Nebraska Railroad, and occupied the same position with the Kansas City, Fort Scott & Memphis Railroad, when forced to retire from active service through continued ill health. He was a brother of Mr. A. N. Towne, of the Southern Pacific.

Lewis Morris Rutherfurd, who died at his residence at Tranquility, N. J., May 30, aged 75 years, was one of a class which the conditions of life have made rare in this country. Inheriting a sufficient fortune to relieve him from the necessity of working for a support, he devoted himself entirely to scientific pursuits. He was born in Morrisania, N. Y., and studied law, but gave up that profession for the study of physical science, especially astronomy, in which he attained considerable eminence. He was a leader in astronomical photography and spectral analysis, and published a number of valuable papers on those subjects. He devised and constructed a number of improvements in telescopes, and about 1870 made a ruling engine capable of cutting 17,000 lines to the square inch. This has never been surpassed, except, perhaps, by the one lately completed by Professor Rowland in Baltimore.

Sidney Dillon, who died in New York June 8, aged 80 years, was born in Montgomery County, N. Y. His parents were poor, and at 10 years of age he began work as a waterboy for a gang of laborers on the old Mohawk & Hudson Railroad. Gradually rising as he grew older, and accumulating some money, he started at last as a contractor on his own account. He built sections of the Western, now the Boston & Albany, the Hartford, Providence & Fishkill, and other roads in New England, and part of the Central Railroad of New Jersey. He built the Fourth Avenue improvement in New York, by which the track of the Harlem Railroad was placed either below or above the street grades from Forty-second Street to the Harlem River. His most extensive work was on the Union Pacific Railroad, a large part of which he built. He owned a large interest in the stock of the company, and was its President for a number of years.

Of late years Mr. Dillon had retired from the construction business, although he had been actively engaged in the management of railroad properties in which he was an owner. He had generally been allied with the Gould interest in the Union Pacific and other roads. He leaves a large fortune, chiefly invested in railroad securities.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, June 1, a paper by Mr. H. H. Quimby on Wind Bracing in High Buildings was read and discussed at some length.

A paper by Professor A. J. Du Bois on a New Formula for Strength of Columns was read and discussion postponed.

The following elections were announced:

Members: Jean Pierre Ferriere, Blida, Algeria; William L. Marshall, U. S. Engs., Chicago, Ill.; Robert K. Martin, Baltimore; David A. Poynor, Dallas, Tex.; Charles Walker Raymond, U. S. Engs., Philadelphia; Horace See, New York; Charles Edwin Wells, Chicago.

Associate Members: Julius Baier, St. Louis; Griffith M. Eldridge, Americus, Ga.; Harry Hardy, Tabasco, Mex.; August Mayer, Los Angeles, Cal.; John Van Wicheren Reynders, Steelton, Pa.; Elmer Wayland Ross, Providence, R. I.; Louis L. Tribus, New York.

Associate: George Hervey Ely, Cleveland, O.

Juniors: George T. Barnsley, Dingess, W. Va.; Shirley Carter, Baltimore; James H. Edwards, East Berlin, Conn.; Charles H. Jewett, Julius A. Ludwig, New York; Robert E. Neumeyer, Bethlehem, Pa.; William H. Penn, New Britain, Conn.; Gabriel C. Tuthill, Detroit, Mich.

The annual convention, at Old Point Comfort, Va., began June 8, a large number of members being present. Those attending from New York and the East generally reached the place of meeting by a special train, which left New York on the previous day, running by way of Wilmington and Cape Charles. On the first day three sessions were held, which were generally devoted to the reading and discussion of papers. At the evening session, President Cohen delivered his annual address. This was chiefly historical, beginning with the early history and conditions of the city of Baltimore which led up to the building of the Baltimore & Ohio Railroad, in which Mr. Cohen did his part.

Thursday, the second day of the convention, was spent in excursions, members being taken by steamboat to Norfolk to the Navy Yard, and thence by rail to Virginia Beach, returning in the evening.

On the third day morning and evening sessions were held, the morning one being a business meeting. In the afternoon members visited Fortress Monroe, where a special artillery practice was given for their benefit, and the work in progress on the fort in charge of the Corps of Engineers was inspected.

Saturday was chiefly taken up by a visit to the great yards of the Newport News Ship Building Company. In the evening the usual annual banquet took place, at which most of the members attending the convention were present, and a number of speeches were made.

On Monday, the last day of the Convention, a final session was held for reading of papers and discussions, and the convention adjourned.

While a number of interesting papers were presented at this convention and there were some excellent discussions, no action of special importance was taken. There were some discussions over the new rules adopted by the Board of Directors concerning the publication of papers in advance of their appearance in the Transactions, but no decisive action was taken, the matter being practically left to the discretion of the Board.

New England Water-Works Association.—The annual meeting was held in Holyoke, Mass., beginning June 8. An address of welcome was made by the Mayor of the city.

After some new members had been admitted, President Holden gave an address. He said the Association has been in existence ten years, and when it was formed in Young's Hotel, at Boston, ther were but 25 members. Now there are 391. The treasury has a balance of $1908, and affairs are in a prosperous condition. The members should educate themselves in

regard to the varying and increasing problems of water supplies. The manner in which disease germs are carried in flowing streams is just being understood. The members may not be sufficiently versed in chemistry to enable them to decide some matters of importance, but they can be educated to be able to handle many of them. A permanent location is needed for the Association, and a place where the Secretary can compile the records and keep them for future reference. There are 325 water-works in New England, and 102 are represented in the Association.

Papers were read on the Ellis System of Fire Protection ; on Coating Cast-Iron Pipe ; on Detecting Waste, and on the Water-Works of Franklin, N. H.

On the second day two sessions were held, at which papers were read on the Cambridge Syphon ; on an Experiment which Failed ; on Aëration of Water ; on the Venturi Water Meter ; on Cleaning Water Mains ; and on Land Filtration. There were discussions on several of these papers.

It was decided to hold the next yearly convention at Middleboro, Mass. The following officers were elected : President, George F. Chace, Taunton, Mass. ; Vice-Presidents, George E. Batchelder, Worcester, Mass. ; F. P. Webster, Lakeport, N. H. ; J. L. Congdon, East Greenwich, R. I. ; J. A. Butler, Portland, Conn. ; F. H. Crandall, Burlington, Vt. ; W. E. McAllister, Calais, Me. ; Secretary, R. C. P. Coggeshall, New Bedford, Mass. ; Editors, Dexter Brackett, W. H. Richards ; Executive Committee, F. E. Hall, J. E. Tenney and George A. Stacy ; Finance Committee, F. H. Andrews, A. R. Hathaway and J. L. Harrington.

Between the sessions and after the adjournment the members made visits to the water power and other points of interest in Holyoke and the neighborhood.

Franklin Institute.—At the regular meeting, in Philadelphia, May 18, Mr. W. G. Collins read a paper on the Aërated Fuel System of burning petroleum ; Mr. C. J. Hexamer read a paper on the proper methods of constructing Public Buildings, with reference to security against fire ; Mr. W. N. Jennings exhibited a number of lightning photographs, and described his process of taking them.

The Committee on Science and the Arts on June 1 adopted a report recommending the grant of the Elliott Cresson Medal to Lieutenant Bradley A. Fiske, U. S. N., for his invention of a range and position finder for naval and other service.

At the regular meeting, June 4, it was announced that at the last meeting of the Board of Directors, held May 31, Professor L. F. Rondinella was appointed Secretary of the Club, for the unexpired term of Mr. John C. Trautwine, Jr., resigned.

No paper was presented, but there were discussions on the Location of the New Mint ; on Shearing of Iron and Steel, and on the proper proportions of Valve-area to Cylinder-area in high-pressure pumps. Nearly all the members present joined in these, and some interesting facts were brought out.

Engineers' Club of Philadelphia.—At the meeting of May 7 the discussion of the trolley system for running electric cars was continued. Papers were read by Messrs. Carl Hering and C. H. Roney, and the verbal discussion was carried on by Messrs. Hering, Salom, Ford, Smith and others, some interesting statements being given.

At the meeting of May 21 the resignation of Mr. John C. Trautwine, Jr., as Secretary was accepted, with expressions of regret.

The tellers reported the following gentlemen elected members :

Active : Edward H. Jenkins, B. Antrim Haldeman, William G. Hartranft and Clement B. Webster.

Associate : J. Walter Douglas.

The Secretary read a description of blue prints submitted by Mr. C. S. Sims, Jr., and exhibited, descriptive of designs for an Aerial Watch-box for railroads.

Mr. Teile Henry Müller read a paper upon Evaporation by Multiple Effect. The paper was illustrated by a number of blue prints, representing different forms of multiple-effect evaporators.

This paper was discussed by Messrs. Müller, Morris, Falkman and others, who gave some experiences with refrigerating machinery.

Engineers' Society of Western Pennsylvania.—At the regular meeting of the Society in Pittsburgh, May 17, Mr. John W. Seaver read a paper on Iron Mill Buildings, the object being to give a brief description of some of the most important points in the construction of Mill Buildings in such a way as to enable a party who contemplates the erection of a building to decide upon what will give him the most satisfactory return for his money, and to compare the merits of the various plans and proposals that may be submitted for his consideration.

In the paper as read before the Society there followed a complete enumeration of the various points in the design of a building and a specification of loads to be allowed, for quality of material required, unit strains for members, etc.

At the regular meeting of the Chemical Section on May 24, the following officers were chosen : Chairman, John W. Langley ; Vice-Chairman, Dr. Charles B. Dudley ; Secretary, James O. Handy ; Representatives on Board of Directors, James M. Camp and George Marsh.

The Committee on Handy's Phosphorus Method reported that it would be necessary to modify the procedure in analyzing ferromanganese and speigel, as the phosphorus and carbon in these materials resisted oxidation by permanganate solution, and evaporation to hard dryness gave complete oxidation.

A paper was read by Mr. C. P. Van Gundy on Manganese Estimation in Iron and Steel by Textor's Method, Modified. His results showed that the method with slight modification gave accurate results through a very wide range of manganese percentage. The paper was discussed by Messrs. Langley, Handy, Johnston, Van Gundy and Carnahan.

Chairman Langley then described a new method of estimating Copper in Iron or Steel.

Mr. Handy spoke of difficulties encountered in estimating the percentage of Tin in Tin-plate, and described how it had been successfully done.

Alabama Scientific Society.—At the annual meeting in Birmingham, Ala., May 18, it was decided to hold the next meeting at Birmingham in November.

Dr. William B. Phillips read a paper on the Composition of Alabama Cokes, which was discussed at some length.

The following officers were elected for the ensuing year : President, C. A. Meissner, Birmingham ; Vice-President, T. H. Aldrich, Blocton ; Secretary, Dr. Eugene A. Smith, Tuscaloosa.

Engineers' Club of Cincinnati.—At the May meeting of the Club three new members were elected, and one application for membership was received.

In place of the usual paper on some engineering topic, Mr. E. J. Carpenter, of the United States Engineer Department, entertained the members and their ladies with a lecture, illustrated with lantern pictures, on the subject "Photography as an Aid to Engineering." The lecture dealt principally with the work performed by the dredging fleet on the Ohio River, of which Mr. Carpenter is in charge. The balance of the evening was spent in the discussion of a light repast and in general sociability, and the whole proved an agreeable diversion from the usual programme.

Engineers' Clubs of St. Paul and Minneapolis.—A joint meeting was held in St. Paul, Minn., May 21. Before the meeting the members inspected the new bridge shops and foundry of the Gillett-Herzog Manufacturing Company, of Minneapolis. At the meeting Mr. Wilson, of the St. Paul Society, read a paper on Tunnels in St. Paul and Vicinity, which was followed by some discussion.

Technical Society of the Pacific Coast.—At the regular May meeting in San Francisco the following members were elected : William H. Davenport, Visalia, Cal.; W. O. Secor, Albuquerque, N. M.; Robert Hall, M. M. O'Shaughnessy, Alexander Watson, San Francisco.

The main proceeding of the evening was a lecture on Silver and its True Place in Circulation, by Mr. J. W. Treadwell. This included a review of the circulations of the various nations of the world.

At the June meeting Mr. Marsden Mansen read an interesting paper on the Circulation of the Atmosphere of the Planets.

Engineers' Club of St. Louis.—At the regular meeting, May 18, a paper on Maximum Stresses in Draw-bridges, by Professor M. A. Howe, was read, and was subsequently discussed.

Professor Johnson exhibited an apparatus designed by him and constructed by Maher & Company, St. Louis, for measuring the elongation or compression of test specimens while under stress. It consists of two collars fastened to the speci-

men by set screws, each carrying a graduated circle four inches in diameter, over the face of which moves a balanced pointer. This pointer carries a small vernier and is attached to a spindle, in which is a friction roller measuring exactly one-half inch in circumference. The roller on one spindle is operated by an arm which is attached to the other collar, these arms being mounted symmetrically on opposite sides of the specimen. The apparatus reads with exactness to the nearest one-ten-thousandth of an inch, and registers elongations beyond the elastic limit as readily as it does those below that limit. Its operation is very satisfactory.

AT the regular meeting, June 1, the usual routine business was transacted and subscriptions to the leading engineering papers ordered.

Mr. Flad presented some diagrams showing loss of head for the flow of gases through pipes of varying diameters and for varying velocities. Discussion followed by Messrs. Wheeler, Colby, Flad and Love.

Mr. Ockerson exhibited blue print diagrams showing the effects of erosion on the Mississippi River banks, from Cairo to Donaldsonville, from 1877, 1883 to 1892. The diagrams showed graphically the annual amount of caving per mile of river considered in sections of 10 miles. Discussion followed by Messrs. Colby, Wheeler, Flad and Crosby.

NOTES AND NEWS.

A Large Plate Girder Bridge.—The Boston Bridge Works at Cambridge, Mass., recently shipped two heavy steel plate girders, to be placed over Southbridge Street, Worcester, for the Providence & Worcester Division of the New York, Providence & Boston Railroad.

The two girders, each 95 ft. 8½ in. long, were put together in the shop and shipped in single pieces.

Each girder is 9 ft. deep, too wide to safely lie flat on a car. They were therefore loaded on edge, each on three long flat cars. Each girder weighs 57,715 lbs.

The bridge structure will be 17.4 ft. wide, and will be supported by these two girders, resting on stone abutments.

An interesting feature in the construction of this bridge is its floor plan. The foundation is a series of steel V-shaped troughs, side by side, lying transversely to the tracks and resting in sockets riveted to the girders. The troughs are bent at right angles and are about 18 in. deep.

These are to be filled with cement or concrete, and over this will be placed the material of an ordinary roadbed. The result is a thorough protection of the bridge floor from fire or storm, the deadening of sound, and the making of a tight and solid floor.

Petroleum Burning in Russia.—A number of locomotives on the St. Petersburg-Moscow and the St. Petersburg-Warsaw lines, in Russia, are now being prepared to burn petroleum. Experience with oil-burners on the Southwestern Railroad has shown that oil can be supplied at a cheaper rate than coal to almost any of the Russian lines, except, perhaps, those in the Baltic provinces.

Lengthening a Stand-Pipe.—Owing to the steady growth of Mt. Vernon, N. Y., it became necessary, in order to obtain greater pressure for elevated points, to enlarge the stand-pipe. The old affair was originally 100 ft. high, 20 ft. in diameter, and weighed about 75 tons. It was built of 5-ft. plates, double riveted vertical seams, and had a capacity of about 235,000 gallons. To increase the pressure the stand-pipe was raised 25 ft. with handjacks and blocked. The extension of 25 ft. was made of tank iron, 12½ ft. of ½-in. and 12½ ft. of $\frac{9}{16}$ in. iron, having a tensile strain of 50,000 lbs. per sq. in. of section.

The present height of the stand-pipe is 125 ft.; diameter, 20 ft., with capacity of about 300,000 gallons. The stand-pipe was raised in thirteen days. The placing of the extension and connecting force main took nearly thirty days. The cost of the entire work was about $5000. Isaac A. Blair & Company, of Boston, did the raising, and the iron work was done by the Cunningham Iron Works of South Boston.—*Fire and Water.*

An Old-Time Sound Boat.—Our marine contemporary, *Seaboard*, is publishing a very interesting series of articles on the old-time steamboats of Long Island Sound. From one of these we take the accompanying illustration of the *Chancellor Livingston*, which was built in 1815. The history of this boat is given by *Seaboard* as follows:

"She was designed by Stoudinger, and was two years building; when finished she was the most elegant steam vessel in the world—the *Puritan* of the steamboats of that day. Her hull was built by Henry Eckford, and the joiner-work executed under the direction of David Cook. Her engine and boiler were constructed by James P. Allaire. Her boiler was of copper, but on a new model, having a large cylindrical flue, with two small return flues and a false front. She was the first boat having a cabin on the main deck, with a promenade above. She cost, complete, $110,000.

"The *Livingston* made her trial trip on Saturday, March 29, 1817, going to Newburg, a distance of 60 miles, which, according to those on board, 'was accomplished in a few minutes less than nine hours, of which time the tide was in her favor only three hours. In returning, the same distance was run in 8 hours and 15 minutes, the greater part of the time against a flood tide and south wind.' It was expected that she would go to Albany in about 20 hours, and she did a number of times. Her fastest run that year to Albany was on December 5, when she went up in 18 hours.

"The *Livingston* continued on the Hudson until March, 1828, when she was placed on the New York & Providence line as an opposition boat, with Captain Coggeshall in command.

THE "CHANCELLOR LIVINGSTON," 1828.

She had been rebuilt during the winter previous, and now appeared with three boilers and three smoke stacks, as is shown in the illustration. The other steamers running between the two places were the *Fulton*, *Connecticut* and *Washington*. The steamboat *Long Branch* was placed on the same route later in the season, and a new boat, the *Ben Franklin*, appeared in September that year. The latter was said to be the best boat on the Sound, but it was claimed that the *Livingston* was the fastest. The *Livingston* continued to run for a number of years. She became a great favorite, and the superb meals that were always to be had on this boat added not a little to her popularity. She ran independently during 1831–32, keeping the fare down, and the steamers *President*, *Connecticut*, *Providence*, *Franklin*, and *Boston* were on the other lines. In 1834 the *Livingston* went to Boston, where she struck a rock in the harbor and sunk. She was raised again and placed on the Boston & Portland line, where she ran for a number of years. Her hull having been condemned, it was broken up and her engine put into the new steamboat *Portland*."

The Hawarden Bridge.—A paper recently presented before the British Institution of Civil Engineers by Mr. Francis Fox gives a description of the Hawarden Bridge over the River Dee, built under his charge, which has the longest clear opening of draw span in England.

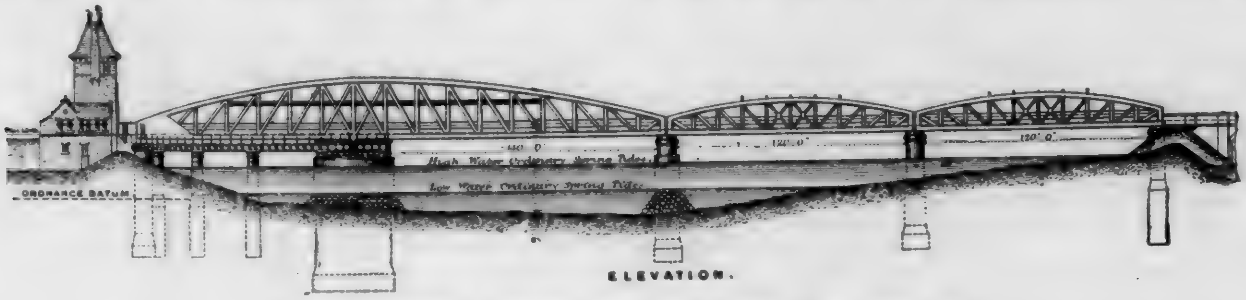
The bridge consists of two fixed spans of 120 ft. each, and of one swing portion, 287 ft. in length over all, which gives two unequal openings, the largest of which, being for the navigation, is 140 ft. clear span, while the tail end of the girder gives a clear span of 87 ft. The bridge carries a double line of railroad, with a footpath, 4 ft. in width, supported on cantilevers outside the main girders.

The piers are founded on brick wells, a system much used in India, the brick columns or wells built in iron caissons sunk in the bottom of the river, which is of soft, shifting sand.

The swing bridge consists of two main girders, constructed of mild steel, each having a total length of 284¾ ft., and a total

depth of 32 ft. at the pivot, and $9\frac{1}{4}$ ft. at the ends. The pivot is $116\frac{1}{2}$ ft. from the tail end, and $168\frac{1}{4}$ ft. from the fore end of the girder. The girders are $27\frac{1}{2}$ ft. apart, center to center; and the clear width inside is 25 ft. 2 in. The girders are lattice, divided into panels, 17 ft. wide, with single, triangulated, vertical and diagonal members, except over the pivot where the members cross each other. The top booms are curved and bow-shaped, and the bottom booms are horizontal. The sections of the various members are of the simplest form, the connections being made by junction plates and rivets; and smith's work was avoided wherever possible. The bottom booms are of a square trough section, and the top booms are the same, but inverted. The lattice members are of **I** girder section, made of plates and angle irons. The short end of this span is provided with a balance weight to counterbalance the additional length of the other end.

The draw-span is moved by two hydraulic rams placed on heavy bed-plates on the center pier. Both rams are single acting and are geared with chains in the proportion of 2 : 1; one ram opens and the other closes the bridge, the chains acting on the central bearing. The rams are 19 in. in diameter and 151 in. stroke, this being sufficient to turn the bridge through an angle of 90°. The boilers, pumps and accumulators are in a building at the Cheshire end of the bridge, which is shown in the engraving.



THE HAWARDEN BRIDGE OVER THE RIVER DEE, ENGLAND.

An Indian Suspension Bridge.—The accompanying illustration, from *Indian Engineering*, shows a suspension bridge which has stood the test of long service, and which was built wholly from native Indian material and by native labor, from the designs and under the direction of Major Duncan Presgrave. It carries a highway having a large traffic, and crosses the Beosi River near Saugor.

The foundations of the bridge, which was designed with one span of 200 ft. between centers of suspension, were laid in April, 1828, and the bridge was opened for traffic in June, 1830.

The abutments were built of stone quarried in the neighborhood, set in mortar also made of locally burned lime, and rose up from the rocky bed of the Beosi River with a batter of 1 in 5 to a height of 42 ft. over the rock, showing a clear height of 36 ft. over low water surface, the batter giving an impression of massive strength in keeping with the surroundings of the bridge. The abutments were continued on into wing walls which ran into the banks on either side a distance of 26 ft., rising up with a batter of 1 in 8, this being also the batter of the abutment faces in line with them.

The points of suspension were designed in the ordinary way over the haunches of the archway over the abutments, the roadway passing under cut-stone faced archways 15 ft. in height, and the arches themselves resting on piers 6 × 12 ft. in section at road level.

As finally built, the masonry, including the arches for the suspension chains, rose to a total height of 68 ft. above the rock of the river, and 62 ft. over low water level. Local masons, stone-cutters, and quarrymen, and locally contrived slings for lifting the stone and setting the blocks in position, were used exclusively and with complete success.

The rich iron mines of Bijawar and its vicinity, through which all the three great northerly roads from Saugor pass, furnished an exceedingly pure iron ore, which, smelted in the vicinity of the mines with charcoal from the local forests, furnished the irregular round lumps from which, in the workshops at the bridge site, the finished suspension chains were finally turned out, wholly by local labor; the links of the main chains 15 to $15\frac{1}{2}$ ft. in length of round $1\frac{1}{2}$-in. bar iron, the heavier square anchoring chains, the suspension saddles and the rollers were all forged in these workshops, where also all the bolt holes, the bolts, the nuts, the washers, the suspenders and their stirrups were forged, turned, fitted and had the necessary key-slots cut in them. Lastly, even the longitudinal roadway girders, of flat bars $\frac{3}{4}$ in. thick, 4 in. broad and 15 ft. long (on which the wooden cross beams carrying the roadway rest), and which were carried in the stirrup-loops of the suspending rods, were forged on the spot. These, if not the most difficult in one sense, were certainly the heaviest forgings needed.

SUSPENSION BRIDGE OVER THE BEOSI RIVER NEAR SAUGOR, INDIA.

The workshops, under Major Presgrave, successfully turned out all the complicated iron-work with a finish little inferior to machine, finished work, and of a strength far exceeding in its charcoal smelted purity the strength of any ordinary English machine-rolled iron.

The 12 suspending main chains ranged in 3 *pairs* on each side, 2 ft. apart vertically, weighed $8\frac{1}{2}$ tons, the flat 4-in. bars for carrying the roadway across joists weighed $1\frac{3}{4}$ tons, the suspending rods weighed nearly $1\frac{1}{4}$ tons, and the miscellaneous work, nails, bolts, cornices, string course, etc., altogether brought up the net weight of iron-work, *as it was turned out from the workshop*, to $14\frac{3}{4}$ tons. The paint to cover the iron-work is not included in the above; it weighed $1\frac{3}{4}$ tons on its own account.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, AUGUST, 1892.

A REQUEST for information from manufacturers of railroad material and supplies is presented in another column by Mr. Pethick, Managing Director of the Imperial Railroads of North China, which ought to be freely responded to. Mr. Pethick is trained in American railroad methods and is trying to introduce them in China; and while the field is comparatively a small one at present, it has great possibilities in the future.

THE compound locomotive occupies a good deal of space in the present number. No excuse is needed for this, since almost all the late developments of the locomotive have been on this line, and the interest felt in the question is increasing. Whether the double-expansion engine will have a permanent place on the railroad is still somewhat uncertain, but its careful trial is a matter which interests every one.

A TRIAL of electric motors is to be made on the Second Avenue line in New York, and probably on some other lines in that city. The trolley plan of running cars, which has been so much used, is hardly advisable in a city like New York, and in this case a storage battery system is to be used. The great objection to this system is the weight to be carried, but it is said that this has been partly overcome.

THE dead weight of the motor coming directly upon the track without the intervention of springs has been so far the great objection to electric street cars. There is little question about the working of the motors, but the difficulty has been to find rails which will stand the work and not cost too much.

THE Philadelphia & Reading Company has put a fast train on its line between Philadelphia and Atlantic City, which makes regularly the run of 55½ miles in 60 minutes. This train usually has eight cars, and sometimes an additional one. The road, it may be noted, is almost all level, and has very few curves.

NEW railroad construction for the first half of 1892 is reported by the *Railway Age* at 1,367 miles, a smaller total than for some time past. The greatest mileage reported in any State is 163 miles in New York, the second place being held by Montana, with 127 miles. The new mileage is pretty well distributed, a falling off in the South and Southwest and some increase in the Middle and Eastern States being apparent. The construction has been largely in short lines and branches, only one or two long lines being now under way.

THERE is always more track-laying in the second than in the first half of the year, but the indications are that the addition to railroad mileage this year will be less than 3,000 miles. More money is being spent now on improvements to existing roads than on extensions, and very few new lines of importance are in progress.

THE various bills presented in Congress to compel the adoption of automatic couplers and continuous brakes have been consolidated in one measure by the committee to which they were referred. This bill proposes to leave the adoption of a standard coupler to the Interstate Commerce Commission, in case the roads are unable to agree, and to compel its adoption within three years. The full text of the bill will be found on another page.

Action on the bill can hardly be taken at the present session; but it will probably be urged at the next session, with some probability of its passage.

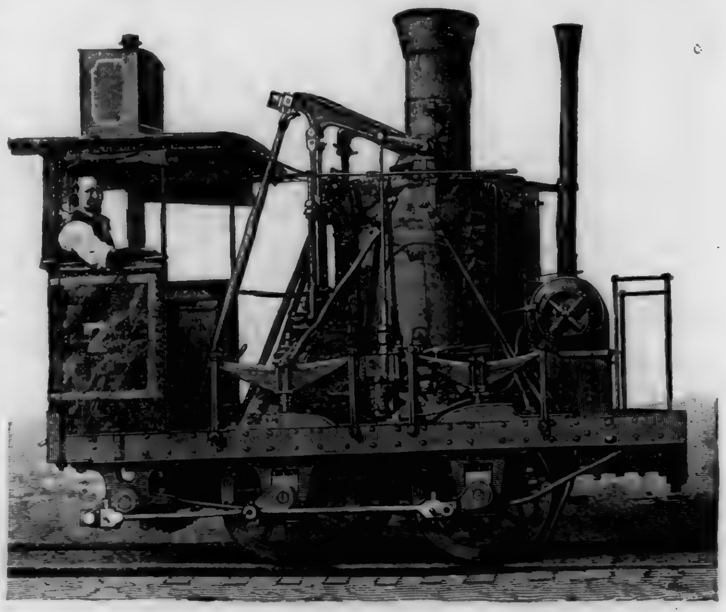
ENGLISH AND AMERICAN LOCOMOTIVES.

THE discussion of this subject, which has been carried on in these pages and those of *The Engineer*, has reached a stage in which its continuance will probably have little further interest to our readers. On June 17 our cotemporary gave another article, in which it was said that the editor of the RAILROAD AND ENGINEERING JOURNAL "insists on having the weights of *all* trains, including those on branch lines." This, he says, was given "in another form" in the table which was republished in these columns last November. Now it happens that in that table there is no intimation at all of the weight of trains. How it can be given in "another form" when weights are not mentioned surpasses our understanding. We gave a table showing that on 16,000 miles of our principal railroads the average consumption of coal for passenger trains, whose average weight was 130.3 tons, was 66.97 lbs., and on freight trains the consumption was 115.7 lbs., and the weight of trains 553.5 tons. The average consumption per ton per mile was .515 lb. for passenger trains and .209 for freight. To this *The Engineer* says the average consumption of all trains on British roads for six months was 37.53 lbs. of coal. Now obviously the key to the significance of these figures is the weight of the trains hauled. Our cotemporary seems unwilling or unable to comprehend what the average weight of *all* trains on a road or a number of roads means.

In its last article he meanders about the subject by giving the weights of the trains which the various representatives of the railways at the time of the Trent brake trials thought conformed to "normal practice." The greatest weight of the trains tested, exclusive of engine and tender, was 195 tons, and the lowest 135. This was in 1875, and he

says trains are heavier now than then, and that if we "had ever seen the work done on the London & Northwestern and Great Eastern lines during the tourist season, he would know that we have understated—not overstated—the weight of passenger trains." Esteemed cotemporary, you said the average number of passengers carried in the regular train of the Caledonian Railway was 120, and that it weighed 125 tons. What did you mean by "*regular*" train? We showed by the statistics of your Board of Trade that if by "regular" train you meant average train, that the Caledonian Railway was carrying passengers for less than any other railway in the world. We have not the least doubt of the fact that some of the passenger trains on your roads are heavy. The question at issue is, what is the average weight of all of them? We may remind you, too, that the dictionary meaning of the word "average," when used as an adjective, is "equal in amount to the sum of all the particular quantities of the same sort, divided by the number of them." The average weight of all the trains on a road or number of roads is the sum of the weights of all divided by the number of them, an elementary fact which somehow you have not been able or willing to grasp. You say, too, that we "entirely overlook the fact that American engines have to haul empty trains just as our own engines have to haul them!" Now if the writer of this sentence knew more of the system of reports employed on American railroads, and made fewer assumptions, he would have known that all companies which report car mileage here reduce the mileage to a basis of loaded cars—that is, two empty cars are reported as equal to one loaded, or five empties as three loads. Our calculations have been made on this basis. Therefore when he says that we "take average consumption and divide it into the weights of loaded trains, quietly ignoring the circumstance that the trains when empty have to be returned whence they came," he has fallen into error, and his statement has the demerit that it is not true. In estimating the average number of freight cars per train given in our Table II, published last November, empty cars are counted as fractions of loaded cars, or, as it is expressed in some of the reports of the railroad companies, "freight car averages are based on loaded freight cars." Therefore if the average number of cars per train is multiplied by the average weight of loaded cars, it will give the correct average weight of trains. The "erroneous assumptions" which our cotemporary attributes to us are in his imagination only, and are the result of too much reliance on that faculty in making some of his statements of fact. There is a similar lack of cogency in some other statements which our cotemporary has made, and which seem to be due to the same cause.

Thus he says that "an American locomotive burning more coal per mile and running many more miles per year than an English engine must wear out sooner." This is a case of *inference* by imagination. Not the slightest evidence has been adduced to prove this bald assumption. It is purely gratuitous, and the inference has been drawn with a perfect disregard of all evidence. Our cotemporary has struggled under the weight of the statistics which we have given, and which show conclusively that the cost of repairs of American locomotives is less per mile run than that of English locomotives, notwithstanding that the former run farther in a given time, pull heavier trains, and that materials and labor here both cost more than they do in England. The significance of our figures, showing the cost of repairs and the service performed by American locomotives cannot be lessened by any exercise of his imagination. One important fact, too, we have not explained. This is that the cost of repairs, as reported by American railroads, covers the cost of rebuilding and replacing old locomotives which are worn out. If an engine becomes unfit for further service, and is broken up, and a new one built to take its place, the cost of the new machine is charged to repairs. In some cases, if the new locomotive is worth more than the old machine was when it was new, the difference in value is charged to some betterment account. The cost of repairs covers the cost of replacing worn-out locomotives with new ones. So far, then, as the system of keeping the accounts is concerned, American locomotives may be said to be immortal, and the cost of immortality is charged to "repairs." It will, therefore, be seen how entirely without foundation of fact the assertion of *The Engineer* is,



"GRASSHOPPER" LOCOMOTIVE, BALTIMORE & OHIO RAILROAD.

that because they cost less for repairs, therefore they must wear out sooner.

It would be interesting, too, to know on what system the repair accounts on English roads are kept. Does the cost of repairs as reported cover the cost of replacing worn-out engines? If it does not, then to that extent is the lesser cost of repairs here still more favorable to American locomotives than our figures have shown it to be.

The danger of depending upon one's imagination for facts is shown in a still more striking way, in our cotemporary's response to our statement that there are locomotives in this country which have been in continuous service for over 50 years. To this our imaginer says:

> If there be really a locomotive 50 years old running in America, it was made, we can assure him, in England. . . . The oldest engine, perhaps, in America which continued working until recently was the *Sampson*, built by Timothy Hackworth, in 1838, and it was exported to Nova Scotia in 1839 with two similar engines, to convey coal from the Albion mines at Stellerton to Pictou Harbor, a distance of seven miles. A simple subtraction sum shows that it is 53 years since 1839. The engine was at work in 1882. Our cotemporary has got,

to use an Americanism, "a little mixed," we think, in his dates.

Our cotemporary on the other side the Atlantic should, we think, lay to heart the maxim that "there is nothing so uncertain as those things of which we are not quite sure." As he has quoted the American language, we may respond in our vernacular by saying that he "is barking up the wrong tree." To make this quite obvious, a little history will be recited, which, it is true, has been told often before, and for that reason there is less excuse for his waywardness. Our historical note and the illustration herewith are taken from "The American Railway; its Construction, Development, Management, and Appliances," published by Charles Scribner's Sons. In that volume it is said:

In 1831 the Baltimore & Ohio Railroad Company offered a premium of $4,000 "for the most approved engine which shall be delivered for trial upon the road on or before June 1, 1831; and $3,500 for the engine which shall be adjudged the next best." The requirements were as follows:

"The engine, when in operation, must not exceed three and one-half tons weight, and must, on a level road, be capable of drawing day by day 15 tons, inclusive of the weight of wagons, 15 miles per hour."

In pursuance of this call upon American genius three locomotives were produced, but only one of these was made to answer any useful purpose. This engine, the "York," was built at York, Pa., and was brought to Baltimore over the turnpike on wagons. It was built by Davis & Gartner, and was designed by Phineas Davis, of that firm, whose trade and business was that of a watch and clock-maker. After undergoing certain modifications, it was found capable of performing what was required by the company. After thoroughly testing this engine, Mr. Davis built others, which were the progenitors of the "grasshopper" engines (illustrated by the engraving herewith), which were used for so many years on the Baltimore & Ohio Railroad. It is a remarkable fact that three of these are still in use on that road, and have been in continuous service for over 50 years. Probably there is no locomotive in existence which has had so long an *active* life.

After designing this first engine and building others Davis was killed during a trial of one of his own machines. After his death the business of building his locomotives was taken up by Gillingham & Winans in Baltimore. The three engines referred to above are still at work on the Baltimore & Ohio Road. They were built in 1835, and have consequently been in service 57 years. We cannot be quite certain at the time of writing whether these three machines were built by Davis & Gartner or by Gillingham & Winans. It is certain though that they were neither designed nor made in England. The engraving herewith was made from a photograph taken about 15 years ago. Since then the engines have been somewhat altered, but not to any material extent. Originally they had four-wheeled tenders. A tank on the engine frame has since been substituted. As shown by the engraving, when they were first built they had a fan-blower which also acted as feed-water heater. This is shown at the base of the exhaust pipe. The required draft was produced by the fan, which was driven by the exhaust steam. The fan was taken off at the time that other alterations were made, and the exhaust was turned up the chimney in the usual way. About 10 or 12 years ago one of the master mechanics at the Mt. Clare shops of the Baltimore & Ohio Railroad told the writer that these engines were so efficient in switching service—in which they were then and have since been employed—that he was strongly disposed at that time to build some more just like them. So far as we know, and we have had excellent opportunities of getting information, these engines have been in continuous use ever since they have been built, excepting during such times as they have been laid up for repairs.

The Engineer says that his "cotemporary [meaning us] has no reason to boast about old engines." We believe that the above statement, while it may not be a good reason for "boasting," will give every American engineer good reason for being proud of the lineage of American locomotives, of which the old grasshoppers are progenitors.

Our cotemporary has charged us with a misstatement of historical facts; will it have the magnanimity to retract the charge?

He asks, "Does the art of building durable locomotives survive only in the United States?" We say, No, it does not, and no one with any adequate knowledge of some of the admirable work which is done in English workshops would say that durable locomotives cannot or are not made there; but we do believe that the art of designing them so as to give the maximum of endurance at a minimum of cost has been carried to a higher degree of perfection here than it has been in his own more conservative country.

Our readers will probably be edified by some very interesting testimony bearing upon the subject of this discussion, which has recently come from our Antipodes. A Royal Commission was appointed some time ago "to inquire into the alleged defective working and unsuitability of the Baldwin engines," which had been ordered for the New South Wales Railway. At a meeting of that Commission, held in Sidney on May 18 of this year, Mr. Eddy, Chief Commissioner of Railways for the Colony of New South Wales, made an elaborate statement to explain the policy that animated the Railway Commissioners in the new departure they made in ordering the Baldwin engines. This statement is very interesting, but is too long to reproduce here; but, among other things, Mr. Eddy said:

The (Baldwin) passenger and goods engines have already run over 450,000 miles, and the average failures are less than with other engines of somewhat similar type. The returns which have been already supplied to the Commission show, I think, that the ordinary running repairs are very moderate when the heavy work the engines are doing is considered. . . .

Previously to the giving of the present order the Government had very satisfactory proof of the class of work turned out by the Baldwin Company—that from having supplied 33 locomotives for the New South Wales railways and 91 motors for our tramways. It was, therefore, no new experiment or departure on our part to obtain supplies from that firm; and as one of the leading partners in the firm had some years ago spent a considerable time in the Colony, they were in an exceptional position to understand our requirements, which were most urgent.

Doubtless the average amount of fuel burned per train mile is less on English than on American lines, yet if the computation were per ton of train hauled per mile, it would be found that the consumption is less in America than it is on English lines, without taking into consideration the difference in the grades and curves. In my opinion there are many features in American locomotives which might with advantage be adopted by English engineers.

With our heavy grades and curves and growing traffic on single lines, a new departure in locomotive power was absolutely necessary, and the results which are beginning to be accomplished clearly demonstrates the wisdom of the action of the Commissioners, the earnings per train mile for the quarter ending March 31 last showing at the rate of 7*s.* 5½*d.* as against 6*s.* 6*d* for the same quarter of 1890; this is upon a total mileage of over 2,000,000 of miles in the quarter. That alone will carry conviction to any one who thinks of railway management. The amount of assisting engine miles (*i.e.*, a second engine with trains) is also being largely reduced.

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With regard to the American goods engines, from very care-

fully prepared returns made by the out-door superintendent and the chief traffic manager, it would appear that during the months of February and March 15 these engines on the western lines saved 27,000 miles, as against working the traffic in absolute full train loads by the most powerful of our ordinary goods engines. These are two light months of the year, and it is estimated that on the whole year's working a saving of about 220,000 miles will be effected. Another great advantage gained is the reduction in risk of accident by having fewer trains on the lines, and the fewer delays that will be experienced in passing the traffic along the single lines. To illustrate this it may be mentioned that in February, between Penrith and Dubbo, 15,219 wagons were moved by 551 trains worked by the American engines, whereas it would have required 796 trains worked by the ordinary engines to have moved this number of wagons.

From still more recent private advices from Australia we learn that indicator diagrams have shown that some of the (Baldwin) engines, on the New South Wales Railways, have exerted a steady tractive force of over 19 000 lbs. when hauling a train of passenger carriages, weighing 144 gross tons, up a gradient of 1 in 30, or 176 ft. per mile. The load was, of course, exclusive of the weight of engine and tender. The weight of the train was obtained by actual weighing on a weigh-bridge. The length of this incline is 2 miles of 1 in 30, or 176 ft. per mile, preceded by ¾ mile of 1 in 33, or 160 ft. per mile.

A point which thus far has not been touched upon in this discussion is the relative cost of British and Yankee locomotives. A comparison of prices from competitive tenders of English and American builders on the same specifications would be interesting, but such data are not accessible to us. But we have it on the authority of an engineer of a large locomotive company here that 1,500 workmen will build 300 American locomotives per year, or 4,500 men will build three locomotives per day; in other words, counting 300 working days in the year, this would be equal to an annual production of 900 engines. That is, there are 1,500 days' (of 10 hours) work on an American locomotive. Our statement is, of course, a very rough one, but it is not believed that it is much out of the way. This rate of production would include engines of a great variety of sizes, big and little, but heavy engines would predominate. How many days' work is there on an average English locomotive?

As a sort of final recapitulation of the subject under dispute, the Editor of *The Engineer* ejaculates:—"We challenge our cotemporary to prove that any non-compound American locomotive has ever hauled a train of 178 tons at 50 to 60 miles an hour with a consumption of 30.6 lbs. of coal per mile"—this being the performance of the engine on the Great Northern Railway, and is equal to .172 lb. of coal per ton per mile. At the present writing we are not able to match the figures which *The Engineer* quotes, but if our cotemporary "has a memory adequate to the trifling task"—to quote his own words—of recalling the figures in the table which we published in our February number, he will there see a report of a train weighing, exclusive of engine and tender, 341 tons, which was hauled 143 miles at an average speed of 45.64 miles per hour, with a consumption of .178 lb. per ton per mile, and another train weighing 261.5 tons was hauled at a speed of 41.85 miles per hour with an expenditure of only .117 lb. of coal per ton per mile. Considering the weight of the trains, this we submit is a more remarkable performance than that on the Great Northern Railway referred to by our cotemporary.

Our cotemporary also asks: "What, for example, does Mr. Buchanan's great engine burn per mile, hauling a train of 117 tons at 50 miles an hour?" We regret that we are not able to answer this inquiry at the present time. Unfortunately for this discussion, but perhaps luckily for the New York Central Railroad, we do not control the engines on that line. No regular account of fuel consumption is kept on that road. Some partial tests have been made of the fuel consumption of the engines referred to, but the results have not yet been made public. But we hope to be able to give the results of more complete tests before long. In the mean while, we may give the recent performance of some of these engines in hauling trains from Buffalo to New York, a distance of 440 miles. On July 7 the train which left Buffalo at 7 A.M. and reached New York at 6.10 P.M. consisted of 1 baggage car, 4 coaches, 1 drawing-room car, 1 dining car and 6 sleepers, or 13 cars altogether. The calculated weight of this train, exclusive of engine and tender, is 409 tons (of 2,240 lbs.). Three engines were employed to haul the train: one from Buffalo to Syracuse, 149½ miles; another from Syracuse to Albany, 147½ miles, and a third from Albany to New York, 143 miles. The schedule time, including 6 stops, is 11 hours, or 40 miles per hour. In making the above run, 10 minutes was lost between Syracuse and Albany. No assisting engines were used.

On July 15 a train consisting of 1 baggage, 1 mail, 1 coach, 1 dining, 1 drawing-room and 5 sleeping cars, or 10 cars altogether, was hauled on the same schedule time. Its calculated weight was 328 tons. With this train one of the engines made up 10 minutes between Syracuse and Albany.

These examples of the daily work on the New York Central Railroad may make it clear to the *Engineer* why locomotives as heavy as those designed by Mr. Buchanan are used in hauling the Empire Express. "If," he says, "I was called upon to design an engine to haul the Empire Express alone, consisting of four cars only, and weighing 117 tons, I would make one which would be more economical in fuel than our present engines are; but after this train commenced running, a fifth car was added, and quite recently a sixth one had to be taken. Our engines must be able not only to haul the increased number of cars on this train, but also to take our other trains, examples of which are given above. If the engines were not able to do so, more of them would be required, and we could not get as great an annual mileage out of them."

In other words, economy in fuel is sacrificed for other more important considerations; and this policy is often followed by locomotive engineers and railroad managers in this country.

If the ejaculatory form of discussion is to be employed, and if our esteemed disputant can grasp the idea of what the average weight of *all* trains on a great railroad means, we will "challenge" him to prove that any great railroad operated by English locomotives is hauling *all* its freight trains with an expenditure of coal of 0.160 lb. per ton per train exclusive of engines, the consumption on the Michigan Central Road for the year 1890, or that on a dozen English roads it is as low as 0.215 lb., the average consumption on 12 American roads given in our Table V, published last December.

We challenge him to show that the average annual mileage of English locomotives anywhere in the world is equal to what we have shown it is on our American roads.

We challenge him to show that any English locomotive has burned as much coal per square foot of grate per

hour as has been and is being burned in locomotives here.

We challenge him to show that any English engines are able to and do haul as heavy trains as are hauled here.

We challenge him to show that the cost of repairs of English locomotives is as low as our data indicate that of American engines is.

We challenge him to show that the cost of maintaining the "immortality" of locomotives in his country is as little as we have shown it is here.

We challenge him to show that the total cost of the service of English locomotives, per ton hauled, on any road with a heavy traffic, is as little as we have shown it is on roads with such a traffic and equipped with American engines.

We challenge him to show that the number of days or hours' work required to build an English locomotive is as little as is required to build an American locomotive.

We challenge him to show that their locomotives run as fast as ours do, but as no one ought to believe his own brother on this subject, reliable evidence should be submitted with the showing.

EXPERIMENTS WITH DYNAMITE SHELL.

SINCE the first discovery of high explosives, nearly half a century ago, efforts looking to their employment in warfare have been unceasing. The early attempts to use gun-cotton as the propelling agent in fire-arms proved so disastrous that the use of high explosive compounds in the military service was for many years restricted to submarine mining and the like; but the proved ineffectiveness of ordinary shell fire against armor-plate has, within the last decade, awakened renewed interest in the subject, particularly in the direction of finding a way of using high explosives instead of gunpowder as the bursting charge of projectiles.

The extreme sensitiveness to shock of nitro-glycerine, dynamite, and all of the earlier forms of high explosives seemed an insuperable barrier to their use in arms whose propelling agent was gunpowder. Although the success of the dynamite air-gun was one solution to the problem, efforts to make possible the use of a high explosive bursting charge in ordinary artillery projectiles were not abandoned. Lieutenant Graydon, Dr. Justin and others, in this country and abroad, have been at work upon the problem. Their experiments have generally resulted, as did the earlier ones of Dr. Justin, in the destruction of the gun when any but the most moderate charges were used.

Generally speaking, the end to be attained has been sought by subdividing the charge of explosive material, and by various methods of cushioning it, so as to reduce to a minimum the initial shock at discharge.

If the press accounts are to be relied upon, the last experiment by Dr. Justin, at Perryville, N. Y., on June 20 proved successful. A 5½-in. Parrott and a 9-in. Blakeley rifle were used. From the former six and from the latter seven shots were fired. The projectile from the smaller gun weighed about 26 lbs. and carried 6¼ lbs. of explosive gelatine; those from the larger gun weighed from 214 to 254 lbs., and were charged with from 30 to 36½ lbs. of the same compounds. The target was the rocky face of a precipice, except that two of the former projectiles were fired through a ⅝-in. and one of the latter through a 3-in. steel plate—the projectiles in each case getting through the plate and being exploded in the backing by a delayed-action fuse. In Dr. Justin's projectile the explosive charge is contained in a separate magazine or cylinder, which, in the last experiment, was of wood instead of metal, as formerly.

No one will deny that great credit is due Dr. Justin for his persistency in following up these experiments after many disheartening failures, and his success is well deserved. Still it must be admitted that while these experiments have been going on success in the use of high explosives in powder guns has been practically achieved along other lines than in the employment of specially constructed shell.

The exhaustive experiments which have been carried on in efforts to perfect a smokeless powder have led to the discovery of a number of high explosive compounds which are practically insensible to explosion by shock or friction. Of the picrate mixtures, the French *melinite* is a well-known example, and one which has been repeatedly and safely used in charging shell. Another and far more powerful class are the nitro-glycerine and nitro-cellulose compounds. In their preparation about equal quantities of nitro-glycerine and cellulose cotton are used, to which is added a solvent, as acetone or acetic ether, and usually a slowing agent, as camphor, tannic acid, or castor-oil. After the evaporation of the solvent the resulting product is a gelatinous mass which may be pressed into sheets or granulated into any desired shape or size, and, dependent upon the varying proportions and manipulation of the ingredients, known as *explosive gelatine, balistite, cordite*, etc.

Granting that it is now quite possible to fire the more stable of the high explosives in shell from powder guns, the problem of getting a projectile so charged through an armor-plate is by no means solved. To detonate any high explosive compounds, stable enough to be fired from a gun, requires a powerful detonating primer or fuse, and it is here that the difficulty lies. The primer in any case must be sensitive, usually of dry gun-cotton or some high explosive mixture, which, although it may safely withstand the shock of discharge, is unable to withstand the shock and heat following impact upon armor-plate of even moderate thickness; and explosion takes place before any great penetration is achieved. The experiments made in France and elsewhere seem to have clearly demonstrated that a steel plate of 4 or at most 5 in. in thickness is sufficient to explode any shell charged with a high explosive.

It might be added that the success of Dr. Justin's, or any other similar invention, will in nowise destroy the value of the dynamite air-gun, as the newspaper critics so readily conclude. This is not only for the reason above given, but also because the projectiles of the largest guns can contain only a very limited charge of explosive material, while the projectile of the dynamite gun is a veritable torpedo, with a charge of many hundred pounds, and capable of destroying where the other missile would explode harmlessly upon impact.

NEW PUBLICATIONS.

THE OFFICIAL RAILWAY LIST. 1892. Chicago; the *Railway Purchasing Agent* Company. Price, $2 in cloth; $3 in flexible leather.

This is the new number of the *Official List*, which is now well

known and from its long-continued publication has become a standard hand-book. It gives a directory of railroad officers, including not only the general officers, but also those in the motive power, road and car departments.

The essential point in such a work is correctness, and the editors seem to have taken much pains to make it correct and bring it up to date, and this is all that can be expected. Constant use of previous numbers has shown them to be generally reliable, and this is certainly the best test that can be applied.

REPORT OF THE BOARD OF STATE ENGINEERS OF THE STATE OF LOUISIANA FROM APRIL 20, 1890, TO APRIL 20, 1892. Henry B. Richardson, Chief State Engineer; Sidney F. Lewis, H. B. Thompson, Frank M. Kerr, Arsene Perrilliat, Assistants. New Orleans; State Printers.

The work of the State Engineer in Louisiana differs in its nature from that assigned to the engineers of any other State, except perhaps Arkansas and Mississippi. His business is the construction and supervision of the great system of levees which protects a large part of the State from the waters of the Mississippi and its tributaries. The report before us gives many interesting particulars relating to this work, the extent of which will be seen from the statement that during the two years covered it involved the building of 171.11 miles of new levee and the raising and enlargement of 347.45 miles, besides the building of 12.70 miles and the enlargement of 18.76 miles in Arkansas, which formed an essential part of the system. This work required a total of 18,481,151 cub. yds. of embankment and an expenditure of $3,632,105.

The Louisiana system now includes 807 miles of levee on the Mississippi alone, besides many miles on the Ouachita, Tensas, Atchafalaya and other streams. Somewhat over half of these are reported at proper grade and in good condition, while about one-quarter of the whole need raising, and the remaining quarter strengthening or other improvement.

This work certainly requires great care, promptness in emergencies, and a variety of resources, and is altogether calculated to call into action the best faculties of the engineer.

THE MICHIGAN ENGINEERS' ANNUAL FOR 1892. Lansing, Mich.; published for the Michigan Engineering Society, F. Hodgman, Secretary.

This volume gives the proceedings of the Michigan Engineering Society for the year, including a number of interesting papers, and the discussions at the annual meeting, which covered a variety of topics. Among the subjects treated are Michigan Building Stones; Hydrographic Surveying; Computation of Earthwork; Surveying Instruments; Disposal of Sewage; Engineering for Cemeteries; besides a number of others equally practical and serviceable. An appendix gives the points involved in a number of recent legal decisions relating to surveys and other matters affecting the work of an engineer.

REPORT OF THE DIVISION OF FORESTRY, DEPARTMENT OF AGRICULTURE, FOR 1891. B. E. Fernow, Chief of Division. Washington; Government Printing Office.

This report contains a statement of the work done during the year by the Division of Forestry, and in addition a discussion of some subjects of general interest in connection with that work. These include Forest Planting Experiments, Forest Reservations and the Kinds and Distribution of the Southern Lumber Pines.

The Chief of the Forestry Division is very much in earnest in his work, the true importance of which is hardly yet appreciated as it ought to be. Forestry is not yet understood in this country, and the extent to which the reckless misuse of our timber resources has proceeded is realized only by a few. The work of this Division must be, for some time to come, chiefly educational, and requires both zeal and knowledge for its conduct. Engineers especially ought to appreciate its great importance; many of them doubtless do so, and are willing to give what aid they can to those who have it in their especial charge.

DESCRIPTIVE INDEX OF CURRENT ENGINEERING LITERATURE: VOLUME I, 1884–1891, INCLUSIVE. Chicago; published by the Board of Managers of the Association of Engineering Societies, John W. Weston, Secretary.

This volume is a reproduction and rearrangement of the "Index Notes" which have appeared monthly in the *Journal* of the Association of Engineering Societies for seven years past. They have been carefully rearranged in proper alphabetical order, with numerous cross-references and a systematic classification by subjects.

It is not by any means claimed that this is a complete index to current technical literature; but it contains over 11,000 notes and references, and it is believed to contain nearly all the periodical and society papers of importance appearing during the seven years covered.

As to society proceedings this claim is probably correct, but the periodical index is hardly as full as might be desired, and even a short examination discloses many omissions. Nevertheless the book will be of service to readers, and will often save them much time and trouble in hunting up the literature of a subject upon which they need information.

RAILWAY CAR CONSTRUCTION. *A Work Describing in Detail and Illustrating with Scale Drawings the Different Varieties of American Cars as now Built.* By William Voss. New York, R. M. Van Arsdale, Morse Building.

In his preface the Author of this book says, very truly, that "we have books on all conceivable subjects, but absolutely nothing, excepting the reports and Dictionary of the Master Car-Builders' Association, on the subject under consideration." Considering the enormous interests involved in car construction, it is remarkable that there has been no treatise in any language on that subject until the appearance of the one which is the subject of this notice. The Author, therefore, had an inviting field and an opportunity seldom offered to a maker of a book. He was induced, he says, when in charge of the car department of a Western railroad a few years ago to write a series of articles on the construction of cars for publication in the *National Car and Locomotive Builder*. It was then the intention to publish them in book form. He disclaims having any literary training to qualify him for the work, and says he engaged in the enterprise much against his inclination. The railroad public may be congratulated on the fact that his disinclination to undertaking the work was overcome, and that he has given it the volume before us.

It is true that it can hardly be regarded as a systematic treatise on the subject, and the title which would perhaps describe it best would be, Notes on Practical Car Building. The subject of car construction is a very much bigger one than most persons are apt to suppose it is, and covers a much wider range of topics than appears at a first glance. Some of these have not been discussed at all in "Railway Car Construction," and others have been treated so briefly and superficially as to leave very much of value and interest relating to them unsaid.

While the Author's want of training and experience, as a maker of books, is indicated in many places, no lack of practical skill or experience, which is of very much more importance in writing such a book, is anywhere apparent.

The book measures 8 × 10½ in., and contains 177 pages and about the same number of engravings. These are nearly all

outline illustrations of the details of cars, made by the "wax process," which leaves nothing to be desired in their execution.

The subjects treated of in the different chapters are: Freight-Car Bodies; Draw-bars and their Attachments; Floors and Framing; Sheathing and Roofs; Doors; Stock Car Bodies; Platform or Flat Cars; Coal, Ore and Refrigerator Cars; Freight-Car Trucks; Truck Frames; Swing-Motion Trucks; Freight-Car Brakes; Power Brakes; Passenger Cars; Dimensions and Floor Frames; Platforms and Couplers; Passenger-Car Framing; Passenger-Car Superstructures; Passenger-Car Trucks; Pullman's Palace Cars; Wagner's Palace Cars; Pennsylvania Railroad's Standard Passenger Car; Pennsylvania Standard Passenger-Car Truck; Standard Passenger Car of New York Central Railroad; Boston & Albany Railroad's Standard Passenger Car; Standards adopted by the Master Car-Builders' and Master Mechanics' Association; and Code of Rules of Master Car-Builders' Association Governing the Condition of and Repairs to Freight Cars.

These subjects are none of them discussed in a comprehensive or systematic way, but what is said of them is in the form of what might be called running notes or observations. As an illustration of this method of treatment, the following paragraph on Body Bolsters, taken from the first chapter, may be quoted. Of these it is said:

> The body-bolster, when made of wood, has a cross-section of about 5 × 14 in. It is locked to the side sills and floor timbers in the manner shown in fig. 9, and fastened to each of them with two ⅞-in. bolts. Those passing through the center timbers are also used to secure the body center-plate, and for this reason are made of ¾-in. iron when four bolts and of ⅞-in. when only two are used. Each bolster is trussed with 1¼ in. iron rods. These may be continuous, but are oftener made with a flat iron center piece or yoke to give a better bearing on the center timbers and to facilitate repairs. In the sketch this yoke is made of ½ by 2½-in. iron, with a pocket welded on each end to receive the nut of the truss-rod, which latter can be replaced when broken in a very short time and without cutting the floor. Fig. 10 shows another form also very extensively used. The end of the truss-rod is provided with a jaw which is bolted to the flat center piece, making a very strong truss, if not so convenient as the other. Blocks of 4 × 5-in. oak are placed on top of the bolster, both to preserve the distance of the sills and elevate the body truss-rods, which latter rest in cast-iron saddles let into these blocks. The space between the center timbers is filled with an oak block to properly support the bolster-truss and center-pin socket. The bolster of a flat car is placed flush with the bottom edge of the side sills, and framed to them with mortise and tenon, the truss-rods passing through the latter, and are provided with a suitable bevel washer.

The descriptions and the observations all through the book are those of a practical car-builder accustomed daily to meet the difficulties of construction and repair. He has troubled himself very little with theories or general principles of any kind. A car has presented itself to him as a structure not built in accordance with any particular theory or on any general principles, but to fulfill certain practical requirements of service and endurance. The defects of construction have revealed themselves to him in their demands for repairs, and until these have manifested themselves in that way he has not bothered himself much about theories of any kind.

Now there can be no doubt that if the general principles of car construction had been adequately discussed, the value of the book would have been much increased; but if we were compelled to choose between a book without any of the science of construction and an abundance of practical knowledge, like the one before us, and another giving all the science and none of the experience of a car-builder, we, and probably most railroad men, would prefer the former.

The general comment on the book is that, while it does not fulfill the demands of a comprehensive treatise on the subject, it is nevertheless a valuable contribution to its literature, and one which will be found generally useful to practical men.

One omission, however, ought to be condemned in the most unrelenting way—the book is without any alphabetical index whatsoever, excepting to the advertisements, which had better be left out. This omission is inexcusable in either the Author or publisher, and ought to be supplied when a new edition is published.

THE CAIRO BRIDGE. REPORT OF GEORGE S. MORISON, CHIEF ENGINEER, TO THE PRESIDENT OF THE CHICAGO, ST. LOUIS & NEW ORLEANS RAILROAD COMPANY. Chicago.

A review of this work would hardly be possible or profitable without republishing a very considerable part of it. It may be sufficient to say that it is another one of the admirable monographs on great bridges for which the engineering public is indebted to Mr. Morison. A more complete account of the structure could hardly be given. It includes full descriptions of the work on the substructure, the superstructure and the manner of its erection, with the contracts and specifications and records of the daily progress of the work and of the tests of the material.

The Cairo Bridge has been before referred to in our columns; crossing the Mississippi at a point where the nature of the bottom required special care in foundations, the most difficult work involved was in locating and building the piers and abutments, and the methods adopted in this work were very interesting.

The drawings accompanying the monograph give maps, views of the different piers, details of the construction of the caissons, and very complete details of all the steel work.

It may be added that the Cairo Bridge proper consists of nine through and three deck spans; two of the through spans are each 518.5 ft. long and the others are 400 ft. each. The three deck spans are 249 ft. each, the total length of the bridge proper being 4,644 ft. The viaduct on the Kentucky approach consists of 21 spans of 150 ft. each and one span of 106.25 ft., while the Illinois viaduct consists of 17 spans of 150 ft. each, and one of 106.25 ft. The total length of the metal work from end to end is 10,560 ft., making it the longest metallic structure across a river in the world. In addition to this metal structure there are in the two approaches 9,901 ft. of timber trestle, making the entire length 20,461 ft., or 3⅞ miles.

TRADE CATALOGUES.

Car Seats, Chairs, etc. Illustrated Catalogue of the Wakefield Rattan Company, Boston.

This catalogue illustrates and describes a variety of patterns of car-seats and chairs. In car-seats the Company does not confine itself to the rattan seats which are its specialty, but furnishes also seats upholstered in the usual way. It is a great pity that rattan is not more generally used; for suburban cars especially it makes a very desirable seat, easily cleaned and comfortable. Any one who has stepped into a car with rattan seats on a summer day has doubtless realized a comforting sense of coolness and cleanliness, which made the car a pleasant contrast to one with plush—and especially *red* plush—seats.

Presses, Drop-hammers, Shears, Dies and Special Machinery. Illustrated Catalogue of the E. W. Bliss Company, Brooklyn, N. Y.

The E. W. Bliss Company not long since absorbed its chief rival in business, the Stiles & Parker Press Company, and now practically controls its peculiar branch of business. Of the extent and importance of this branch some idea can be formed from the catalogue now before us. Very few, if any, books of the kind can be found which illustrate so great a variety of tools. The drop-hammer and the press have grown

to be important factors in many branches of metal manufacture, and they are found here in almost every variety. Stamping-presses, drawing-presses, shears, dies and a large number of similar tools are included; the shops also make milling machines, boring-mills and lathes, and undertake the construction of special machines.

As may be supposed, the catalogue is a work of considerable size, making a solid volume of 390 pages. The illustrations are generally very good.

Steam Engines and Boilers. Catalogue of the Watertown Steam Engine Company, Watertown, N. Y. Illustrated.

This catalogue contains illustrated descriptions of a number of engines built by the Company named. The different varieties include an automatic cut-off engine for general service; a stationary engine of somewhat similar design for heavy work; the "Excelsior" straight-line engine, a type especially designed for general work, and several patterns of portable engines mounted upon the boiler. Of these latter several are so arranged that they can be removed and placed on a separate foundation when desired. The catalogue also illustrates several patterns of boiler both of the cylinder and locomotive type. In addition to these, the Company also builds a traction engine which can be used as a portable engine for running agricultural machinery as well as for hauling heavy loads over a road.

Detroit Sight-Feed Lubricators. Detroit Lubricator Company, Detroit, Mich. Illustrated.

This illustrated catalogue gives a description of the various patterns of sight-feed lubricators made by the Detroit Lubricator Company, the quality of which is well known. In addition to these, the Company manufactures the Garfield injector, a special lubricator for air-brake pumps and a number of smaller devices for locomotive and other engine work. A very neat device for the steam connections of locomotive boilers presents so many excellent points that we have illustrated it on another page. Another device for locomotives which is well known is the Pendrey throttle-valve.

Corrugated Steel Furnaces. Illustrated Catalogue of the Continental Iron Works, Brooklyn, N. Y.

The use of corrugated iron furnaces for marine and stationary boilers has become so general that there is very little to be said about their application. This very handsomely illustrated catalogue shows the arrangements adopted with these furnaces in a large number of different boilers, including those for several of the new cruisers, several for other steamships, and a number of stationary boilers. A long list of vessels on which the corrugated furnace is in use is also given, and the catalogue concludes with rules for calculating the working pressure allowable on such furnaces according to the rules of the United States Supervising Inspectors of steam-vessels.

Jewett Anti-Friction for Car Bodies. Jewett Supply Company, Boston, Mass.

This catalogue contains a description of the Jewett anti-friction device, which consists of a system of roller bearings for the center-pins and the side-bearings of cars. The system is now being tested on the Boston & Albany and the New York & New England roads, so far with very good results.

CURRENT READING.

The July number of the Journal of the Military Service Institute has articles on Smokeless Powders, by Captain Clark; the Prussian Great General Staff, by Captain Bingham; Artillery Service in the Rebellion, by General Tidball; Practical Drill for Infantry, by Lieutenant Johnson; the French Grand Manœuvers of 1891, by Captain Chester; Practical Workings of Rifle Practice, by General Wingate; the Civil War in Chile, by Captain O'Connell. There are also several translations and notes of interest.

In the July number of Goldthwaite's Geographical Magazine there are articles on Columbus and his Times; Physiographic Aspects of New York; Patagonia; a Desert Journey; Chinese Cities; the Rubber Forests of the Amazon; the Pan-American Railroad, and a number of other topics of interest.

The July number of Good Roads contains plenty of excellent material, including articles on several timely topics and a continuation of Editor Potter's papers on Dirt Roads and Gravel Roads. No better work can be done than to circulate this magazine as widely as possible.

A new monthly publication called the Digest of Electrical Patents has been started under the charge of Mr. Ralph W. Pope, a well-known electrical engineer. It proposes to give each month a classified list of all patents issued on electrical matters, with condensed synopses of their claims, etc. It is published at No. 12 West Thirty-first Street, New York.

The August number of Scribner's Magazine is the annual "Fiction Number," and is given up chiefly to short stories, which are perhaps the best reading for the prevailing weather. There is something in the number besides these, however; the series on Historic Moments includes a description of the driving of the last spike on the Union Pacific, written by the late Sidney Dillon. Professor Shaler has an interesting article on Icebergs, and Walter Besant writes of the Poor in London.

The last number of the Proceedings of the United States Naval Institute publishes the prize essay for 1892, which is by William Laird Clowes, on Torpedo Boats; their Organization and Management. It gives also Captain Schley's official report on the *Baltimore*. Other articles are on Electric Welded Projectiles, by H. P. Maxim; Influence of Range Finders, by Lieutenant Albert Gleaves; Notes on Three Guns Captured in Corea, by T. W. Clarke; and the usual variety of notes.

The High Tory or extreme British view of the United States is shown in a very savage article from *Blackwood's*, which is given in the Eclectic Magazine for July. Human Electricity is an article from the *Fortnightly* in the same number, and there is altogether an interesting selection.

The July number of the Arena is quite as bright and full of substance as usual. The leading article is on Mrs. French-Sheldon's explorations in Africa; another, which every one ought to read, is a discussion of the coming political campaign, in which each party's claim is given by its representative, the statements being as fair as could be expected from a thoroughly partisan standpoint

The August number of the Overland Monthly has a number of illustrated articles. Perhaps the most important of these is one on Fishing in Salt Water, treating the subject from a commercial standpoint, and showing the great extent of the industry and the varying methods followed in it. Other articles are on the Repeating Rifle and on Staging in the Redwoods, and there are also a number of sketches of less importance.

In Harper's Magazine for August the last of the articles on the Danube is given. There are illustrated articles on Literary Paris; Corfu and the Ionian Sea; Ice and Ice-making; the Salzburg Exiles in Georgia, and a valuable paper on the Italian Army. The fiction in this number is of a varied character and generally good.

The military article in OUTING for July is by Lieutenant W. R. Hamilton, and treats of the Military Schools of the United States. An appreciative article by C. V. Vaux described the merits of the St. Lawrence Skiff, while the variety of articles on summer travel and sports is even greater than usual, as becomes a midsummer number.

In HARPER'S WEEKLY for July 23 there is an interesting illustrated article on Shipbuilding on the Great Lakes, containing much information on the importance and growth of that industry.

In the August number of the POPULAR SCIENCE MONTHLY the article in the Series of American Industries treats of the Boot and Shoe Manufacture. Mr. Carroll D. Wright treats on Families and Dwellings, the seventh of his Lessons from the Census. A paper by Professor Moss on Natural Selection and Crime requires careful study. An illustrated paper described the great Diamond Mining Industry which has grown up in South Africa.

BOOKS RECEIVED.

Proceedings of the Engineers' Club of Philadelphia: Volume IX, No. 3, July, 1892. Philadelphia; published by the Club.

Transactions of the Canadian Society of Civil Engineers: Volume V, Part II, October–December, 1891. Montreal; published by the Society.

Quarterly Report of the Bureau of Statistics, Treasury Department, on the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending March 31, 1892. S. G. Brock, Chief of Bureau. Government Printing Office, Washington.

Twentieth Annual Report of the Board of Directors of the Pennsylvania Company; for the Year ending December 31, 1892. Philadelphia.

Census of Canada, 1891. *Bulletin No.* 10: *Manufactures. Bulletin No.* 11: *Nationalities.* Department of Agriculture, Ottawa.

Elements of Machine Design. Notes and Plates for the Use of Students in Lehigh University. By J. F. Klein, Professor of Mechanical Engineering. Bethlehem, Pa.; the Moravian Publishing House. We hope to give a careful review of this work in a later number.

Selected Papers of the Institution of Civil Engineers. London, England; published by the Institution. The present installment includes Bruce on the Rosario Water-Works; Wordingham on Meters for Electrical Energy; Binnie on Average Annual Rainfall; Bamber on Transverse Steel Sleepers; Douglas and Salmond on Lighthouses; Curtis on Gold Quartz Reduction; Abstracts of Papers in Foreign Transactions and Periodicals.

TRANSITION CURVES AGAIN.

To the Editor of The Railroad and Engineering Journal:

MY little rule for transition curves in the April number of the JOURNAL was simply devised to save carrying a number of tables into the field, and when used within the usual limits, as shown in the tables of Mr. Raymond and Professor Jameson, confining the curvature of the portion of the circular arc which is ameliorated to 20°, and the offset at *P C* to one-twentieth of the length of that arc, it works very satisfactorily and saves much time and trouble.

I am glad that Mr. Hughes called attention to this point, and will remind him that Mr. Raymond's curve, which I take to be the one he refers to, does not have the chord points "on a curve of a cubic parabola," and so escapes some of the troubles incident to cubic curves when used with great curvatures and offsets. JOHN F. WARD.

SOME CURRENT NOTES.

PERHAPS the most extraordinary work ever done by a lake carrier was by the steamer *Maryland*, which during the month of June carried away from Escanaba eight cargoes of iron ore, making in the aggregate 27,211 gross tons. The largest cargo was 3,507 tons, and the average 3,401 tons. The total amount of work thus done by the ship during the 30 days of June was the loading and unloading of these cargoes, and the running of 4,720 miles. The *Maryland* is a steel steamer built by the Detroit Dry Dock Company in 1890, and is, of course, equipped with all the latest appliances for speedy loading and unloading.

A NEW ship canal project has been brought forward by Professor Haupt, of Philadelphia, and others. The proposition is to widen and deepen the Delaware & Chesapeake Canal, which extends from the lower Delaware to the upper waters of Chesapeake Bay, so as to permit the passage of large ships. The canal is at present 14 miles long, 9 ft. deep and varies from 40 to 500 ft. in width on the surface. There is a tide-lock at each end and one other lock with a lift of 10 ft. It is now proposed to increase the depth to 25 ft. and to make the surface width not less than 170 ft. throughout, and to dispense with the middle lock, leaving only the tidal lock at each end. Owing to the nature of the land through which the canal passes this could be done at a comparatively small expense, the total cost being estimated at only about $2,000,000. The improvement would save some 200 miles in distance for large ships and steamers passing between Philadelphia and Baltimore, besides providing a line entirely inland.

THE block signals of the future were discussed by Mr. J. B. Stewart, who read a paper at the meeting of the Railroad Telegraph Superintendents at Denver. Mr. Stewart believes that the requirements of increasing traffic will be made by a combination of automatic and manual signals, the blocks to be comparatively short, with home signals operated by levers, and automatic signals worked either by electricity or air pressure placed, say, 1,000 or 1,500 ft. apart; the circuit connecting them to be also connected with the lever at the home station, so that when the home signal is placed at danger, the remaining signals throughout will also go to danger. Such an arrangement, he believes, would give ample protection for trains, while mistakes on the part of an operator may be prevented by different devices. One of the requisites of an electrical signal, to which sufficient attention has not been paid, is that all the instruments and batteries should be kept in good working condition and to receive frequent and systematic attention.

ANOTHER paper presented at the same Convention, by Mr. Charles Selden, calls attention to the possibilities of the electric motor in connection with ordinary railroad service. The writer does not believe that the electric motor will take the place of the steam locomotive for regular traffic, but thinks that it may be introduced to advantage for switching service, and to a considerable extent also for suburban service, where it would make possible more frequent trains, and better and more satisfactory service.

IN the near future the portraits that may be made of picturesque and historical Harper's Ferry, Md., will be very different from those now extant. The same mountains and rivers will be there, but the familiar railroad bridge will be taken away, and the entire works of the Baltimore & Ohio Railroad will be altered. The Company has awarded to Messrs. Jones & Thorne, of Baltimore, the contract for making this radical change. It will use up about $250,000 of the $300,000 appropriated for the alteration which will straighten the main line and throw out the awkward reverse curve which now exists on the bridge across the Potomac. It will also do away with the single track on the bridge and change the road radically along two miles of its length. The work of Messrs. Jones & Thorne includes a tunnel 875 ft. long through the

corner of Maryland Heights. From the point where the tunnel emerges they will build eight lofty piers of Gettysburg granite across and in the Potomac River, upon which will be constructed a stone bridge 700 ft. long. Its cost will be defrayed out of the remainder of the money appropriated. The work is to be completed in six months, in time for the World's Fair traffic, and from 600 to 800 workmen, including the quarrymen of the Gettysburg Granite Company, will be employed. The tunnel and the bridge will each be supplied with double tracks and the blocking of trains by the two present signal towers will be obviated. Upon the completion of the improvement a train, instead of curving off to cross the river, will enter the tunnel in the bluff 1,100 ft. east of the old bridge, and following a straight line, will emerge from the mountain-side about 200 ft. from the old bridge and about the same distance back from the river's northern bank and the Chesapeake & Ohio Canal. It will continue by a straight line directly across the canal and river upon the bridge, and strike the West Virginia side 100 ft. west of the old depot in the town of Harper's Ferry. On that side it will continue until it strikes the bluff along which the tracks are to be laid, on the solid mountain-side 400 ft. south of the present tracks. The trains following this course will strike the present tracks a mile above Harper's Ferry. This arrangement will do away with all the trestle work, about ¾ mile long, at Harper's Ferry. It will also straighten out every curve, and prevent many stoppages that occur because of the single track on the bridge. The Valley Branch, which connects with the main line on the West Virginia side, will also connect by a straight line near the West Virginia end of the new bridge instead of striking it by a curve. The contractors have already shipped several car loads of lumber and material to the point of operations, and they are hastening to get to work at the earliest possible moment. The plans for the bridge are under way. The old bridge was built at the close of the war to take the place of the one that was destroyed in course of the hostilities. The Baltimore & Ohio management had the recently adopted plans under consideration many years.

THE production of pig iron is decreasing slowly, the July report of the *American Manufacturer* showing 257 furnaces in blast with a total weekly capacity of 169,850 tons; a decrease of 3,040 tons, or 1¾ per cent., from the June report. As compared with July, 1891, there is but little difference, this year's statement showing an increase of only 2,426 tons, or 1½ per cent., in the weekly capacity of the furnaces in blast.

The total production of pig iron for the first half of 1892 is now estimated at 4,750,000 gross tons. No great changes are probable for a few months to come.

THE Consulting Engineer, Mr. J. B. Johnson, of St. Louis, to whom was committed the tests of the new water-works of the city of Peoria, has made a full report, from which the works seem to be a model plant for a city of moderate size. The tests consisted in an analysis of the water and a study of the geological formation from which it is drawn; an inspection of the pumping station and the machinery; a study of the plans and methods of construction of the reservoir and stand-pipes, and a study of the distribution and pipe system of the city. The water is pumped from a well into which it enters from the river, and a test made by pumping at the rate of 5,000,000 gallons in 24 hours reduced the level in the well only 3 ft. below that of the water. Pumping at double that rate (or 10,000,000 gallons) for seven hours reduced the level to 7½ ft. below the river, and other tests made showed that the water entered the well at a rate sufficient to raise its level about 1 ft. per minute. The test proved sufficiently that the supply through the well is more than equal to all the probable needs of the city for a number of years to come.

Chemical tests showed the water pure and wholesome, but slightly hard, as was to be expected from the nature of the surrounding country, which is almost entirely underlaid by limestone. The water from the river is filtered through nearly one-quarter of a mile of clean gravel before entering the well, so that it is extremely unlikely that any surface impurities should in any way enter it. A considerable part of the supply also comes from the gravel belt through which the well passes, intercepting the ground water-flow for a considerable distance.

The pumping works contain three sets of compound condensing Worthington high-duty pumps, each having two double-acting water plungers 21 in. in diameter. At normal speed these plungers work at the rate of about 140 ft. per minute and the capacity is 9,500,000 gallons in 24 hours. Steam is furnished by three batteries of Heine safety boilers, which are abundantly sufficient to supply the pumps. The machinery has been designed so that there can be no interruption of the regular supply for the city in the case of a break-down of one or even two of the pumps. It is housed in a substantial brick building.

The reservoir has a capacity of 18,000,000 gallons, or sufficient for several days' supply, even should the pumping machinery give out altogether. There are two stand-pipes having a capacity of 500,000 gallons each. Their summits are 320 ft. above the city datum, giving a sufficient head for all purposes.

The distributing system includes 75 miles of cast-iron pipe varying in size from the 30-in. mains leading from the reservoir down to 6-in. and 4-in. pipe.

These works were designed and constructed by the engineering firm of Moffatt, Hodgkins & Clarke, of Syracuse, N. Y., and form, as above stated, a very complete and substantial plant.

THE railroads of Japan, as might be expected from the broken and mountainous nature of the country, have required some expensive work in bridging and tunneling. The longest tunnel in the country is the Yanagase-Yama, on the Tsuruga line, which is 4,435 ft. in length. Four others are over 2,000 ft. long—the Osaka-Yama, 2,181 ft.; the Sekibe, 2,865 ft.; the Isohama, 3,167 ft., and the Makinohara, 3,273 ft. The Tokaido line has 26 tunnels, varying in length from 50 to 3,273 ft.

The longest bridge in Japan is the Tenriu-Gawa, which is 3,967 ft. long, and has 19 spans of 200 ft. each. The Oi-gawa bridge has 16 spans of 200 ft. each. There are no spans of over 200 ft. in the country.

THE Imperial Railroad of North China, which is the chief and in fact almost the only railroad in China, is now —as we have already noted—in charge of Mr. W. N. Pethick, who is an American and is familiar with American methods. Mr. Pethick has been taking such steps as have been in his power so far to introduce American methods, and it is understood that he has made arrangements to place a number of Americans in responsible positions on the road, believing that he can in this way much better meet the requirements of the country, and make the roads successful than by following the English practice, which controlled the first construction and for some time the management of the line. It is natural that this course should arouse opposition from some quarters, and it has been manifested in attempts to reverse his decisions, to depreciate his management and to restore to position some of the former managers. These have failed so far, however, and the present Manager has fortunately the entire confidence of the Viceroy, whose decision is final on all matters connected with the railroad. Upon the success of this line the future of railroads in China is very largely dependent.

THE last message to Congress of the President of the Argentine Republic refers to the Government guarantees of railroad dividends, and declares that there is now a large amount due from the guaranteed lines on account of payments made by the Government, which should have been repaid by the companies from their subsequent profits.

Immediate action to recover this money is recommended. Stricter execution of the laws for the supervision of the railroads is also promised. A number of concessions which had been made for new lines have been cancelled. The President reports that there are now in operation 7,675 miles of railroad in the Republic, of which

625 miles are owned by the State; 925 miles are owned by the different Provinces and 5,865 miles are owned by joint-stock companies. There are also 23 lines under construction, which when completed will add 3,175 miles to this total.

SOME reference has before been made to the investigation ordered by the New South Wales Parliament of the management of the railroad commissioners. One of the points especially to be investigated was the purchase of locomotives for the Government lines from the Baldwin Works in Philadelphia. This was one of the points most strongly urged by the opposition in Parliament, and to some extent this revealed the true animus of the investigation, the purchase of these Baldwin engines having been a very sore point with a certain party in Australia. Political motives, it is understood, were also mixed up in the investigation, which has so far revealed nothing whatever to the discredit of the Commissioners, but, on the contrary, has served to vindicate their management. As to the Baldwin engines, the fact that when they first went into service there was some trouble with broken axles has been made the most of, but it seems that the defective axles were made good by the Company, and that the engines have done very satisfactory work.

NOT much progress is apparent in the various projects for bridges across the Hudson and East Rivers to connect the city of New York with the opposite shores. That there is an urgent need for two more bridges over the East River to connect the city with Long Island, and for at least one and probably two bridges over the Hudson, is generally admitted, but lack of capital, some interested local opposition, and to some extent jealousy and dissension among the advocates of different plans seem for the present to have blocked all progress.

THE New York Rapid Transit plan has advanced another step, the Supreme Court having approved the report of the Commissioners, and the plans submitted for an underground line from the Battery to the northern limits of the city, the details of which have been previously explained. The legal obstacles are now all passed, and the next thing to be done is for the Commission to offer the franchise for constructing the road to that corporation or combination which is willing to undertake it on the most favorable terms for the city.

A COMPOUND FAST PASSENGER LOCOMOTIVE.

IN the JOURNAL for January, 1892, there was published a brief note on the performance of a compound locomotive especially designed for fast passenger service with heavy trains, by M. du Bousquet, Chief Engineer of Material and Traction of the Northern Railroad of France. This engine is a machine of exceptional interest, and in many respects of excellent design. We have received from M. du Bousquet a copy of a paper on this engine and its performance, which was prepared by him for the *Revue Generale des Chemins de Fer*, a condensation of which, it is believed, will present some interesting points. The illustrations herewith show a general view of the engine; a longitudinal section and half plan; two cross sections showing respectively the high and low-pressure cylinders; and an enlarged view of the valve by which the high-pressure exhaust can be turned directly into the smoke-box. The copy from which the illustrations were prepared was, unfortunately, somewhat imperfect, and time did not permit new drawings to be secured; but the general features, it is believed, are sufficiently shown.

The general design of the engine follows the American type of four coupled driving-wheels and a four-wheeled truck, the peculiarities being in the arrangement and connection of the cylinders. It is a four-cylinder compound, having two high-pressure and two low-pressure cylinders connected through an intermediate reservoir. The two high-pressure cylinders are placed outside and immediately in front of the forward drivers; their connecting-rods extend to the outside crank-pins of the rear pair of drivers. The low-pressure cylinders are inside, in the smoke-box, and are connected with cranks on the forward driving axle. The driving-wheels are coupled by parallel rods outside in the ordinary way. This arrangement was adopted after careful consideration and as a result of experience with a four-cylinder compound engine built some time before. The driving-axles are placed, one in front of the fire-box and the other behind it.

It may be noted that the cranks of the high and low-pressure cylinders are not at an angle of 180°, but at 162°—an arrangement adopted to assist the engine in starting.

The locomotives—there are two of them now in service—were built for the Northern Railroad by the Société Alsacienne de Constructions Mecaniques, and have now been at work about seven months.

The boiler is built for a working pressure of 190 to 200 lbs. The barrel is 49.8 in. in diameter inside the smallest ring, and has 202 tubes 1.77 in. in diameter and 12.8 ft. long. The fire-box is 58 in. in depth at the back end and 68 in. at the front; the grate area is 21.96 sq. ft. There is a deflector or water-leg of a kind much in use on the Northern Railroad, and known as the Tenbrink deflector. The heating surface is: Fire-box—including deflector—146.7 sq. ft.; tubes, 1,054.87 sq. ft.; total, 1,200.94 sq. ft. The fuel generally used is bituminous coal mixed with briquettes of compressed fuel, which are much used in France.

The truck has a plate frame and outside journal bearings; the springs are not equalized. The wheels are 40.9 in. in diameter, and the axles are spaced 4 ft. 11 in. between centers.

The driving-wheels are 83.2 in. in diameter, and the driving-axles are 9.84 ft. between centers. The distance from the rear driving-axle to the center of the truck is 21 ft. 11 in. The crank-axle for the forward drivers is of the Worsdell type, with circular jaws.

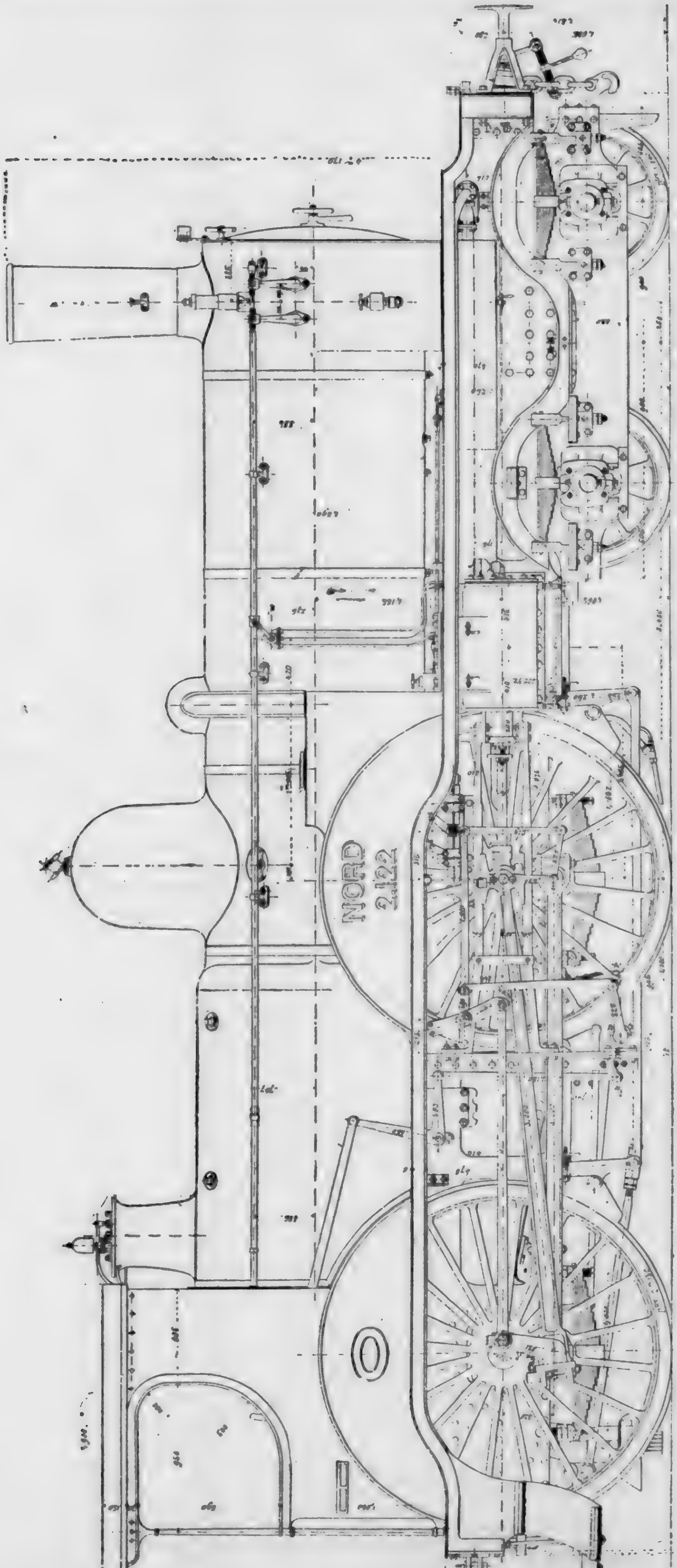
The frames are of the plate type, and are of steel plate 1.1 in. thick. They are solidly braced together in front of the forward driving-axle by a cast-steel box or frame, which also serves to carry the guides for the low-pressure cylinders. The guides, both inside and outside, are double, with cross-heads of the ordinary type, as shown in the engraving. The driving-springs are not equalized.

The high-pressure cylinders are 13.4 in. in diameter and 25.2 in. stroke; the low-pressure cylinders are 20.9 in. in diameter and 25.2 in. stroke. The ratio of the cylinders is 1 : 2.42. The size of the intermediate reservoir is such that the ratio between the volume of the two high-pressure cylinders and that of the reservoir is 1 : 1.36. When working at a boiler pressure of 195 lbs., the pressure in the intermediate reservoir is about 85 lbs.

The valve gear is of the Walschaert type, and there is a separate valve motion for each cylinder. The motions for the high-pressure cylinders are entirely outside, as shown in the drawing. The position of the steam-chests is indicated in the cross-sectional views. The valves of both high and low-pressure cylinders have 1.07 in. outside lap and 0.12 in. inside lap.

The reverse levers for the two sets of valve motions are placed side by side, and are so arranged that they can be worked together or separately at the will of the engineer, the connection between the two levers being made by a spring catch and pin. This enables the engineer to vary the admission to the two sets of cylinders as may be found most advantageous in practice.

For use in starting or in emergencies when additional power is required, an arrangement is provided by which the exhaust from the high-pressure cylinders can be turned directly into the smoke-stack, while at the same time steam from the boiler is admitted through the intermediate reservoir to the low-pressure cylinders. Experience has shown that the simple admission of high-pressure steam to the reservoir, without disposing of the exhaust from the small cylinders, creates a back-pressure in the latter which must be taken into consideration. This apparatus is shown in detail in fig. 6, and consists of a valve with three openings which is attached on each side to the exhaust-pipe connecting the high-pressure cylinder with the inter-



FOUR-CYLINDER COMPOUND LOCOMOTIVE, NORTHERN RAILROAD OF FRANCE.

mediate reservoir. The exhaust-pipe enters a cast-iron box, *A*, the connection being made by an expansion-joint and stuffing-box, *C*. The cylindrical valve *B*, according to its position, permits the exhaust steam to continue directly forward on its way to the reservoir and the low-pressure cylinders, or turns it into the pipe *T*, which leads to the smoke-box. When the valve is placed as shown in the engraving, the high-pressure exhaust thus passes directly to the smoke-stack. A quarter turn of the valve *B* is sufficient to make the change. Motion is given to the valve by the rod or stem *t*, which passes through a stuffing-box *L*. As the working of this valve from the cab by rods and levers would require a somewhat complicated arrangement, it is operated by a small steam cylinder, the piston-rod of which is connected to a lever keyed on the valve-rod *t*. Steam is admitted to this cylinder from the boiler by opening a small valve, and the whole arrangement is a very simple one.

The total weight of this engine ready for service is 105,350 lbs., of which 38,130 lbs. are carried on the truck, 33,830 lbs. on the forward drivers and 33,390 lbs. on the rear drivers; the total weight on the drivers, which is utilized for adhesion, is thus 67,220 lbs.

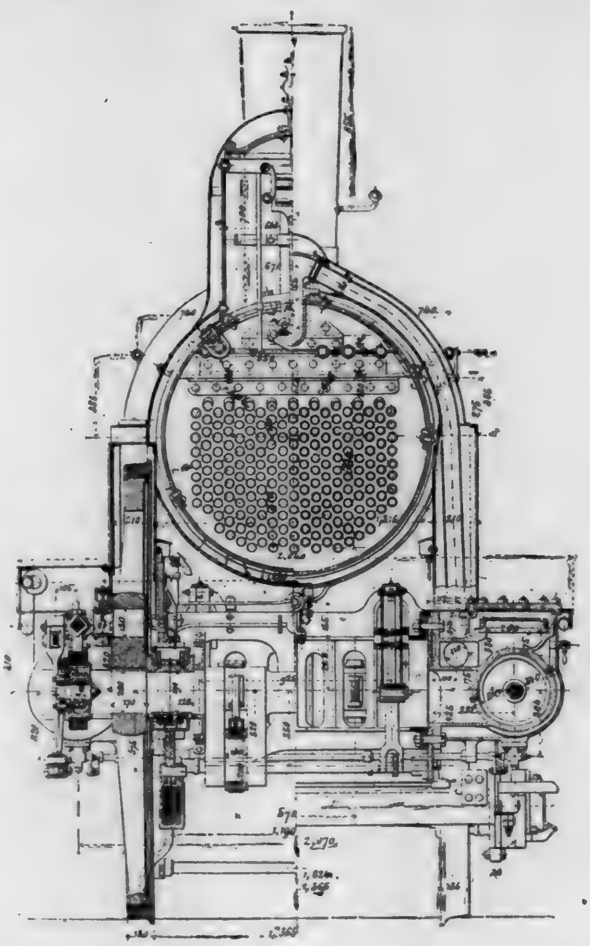
The tender is carried on six wheels of 49.1 in. in diameter. It will carry 3,900 galls. of water and 8,800 lbs. of coal. The total weight with a full load of coal and water is 74,050 lbs.

The total wheel-base of the engine and tender together is 43.8 ft., and their total length outside of the drawheads is 53.9 ft.

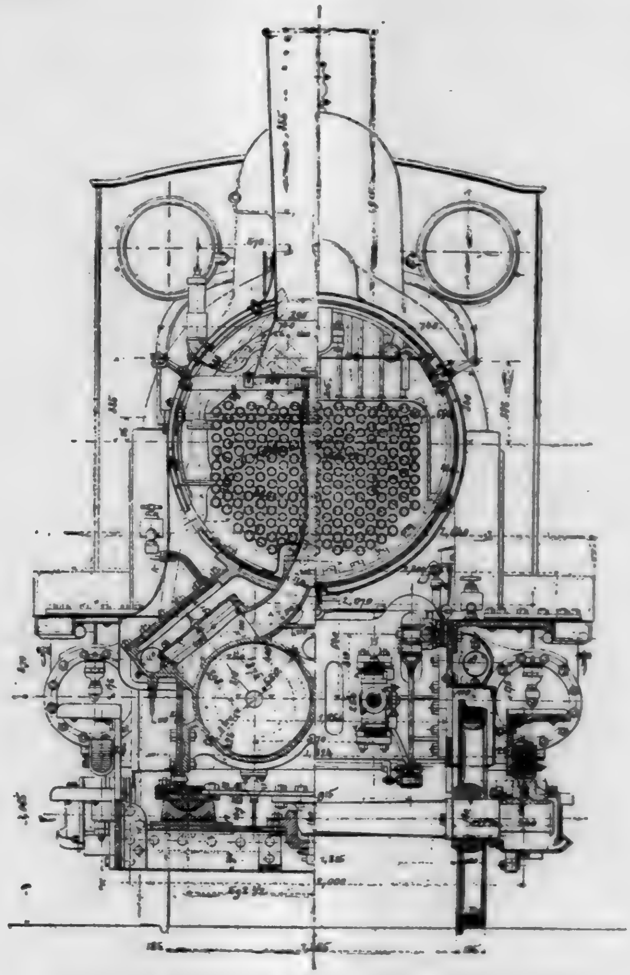
In service these engines have been employed on the fast express trains between Paris, Amiens and Lille, where a high speed is required, with trains varying in weight from 110 to 200 tons, exclusive of the weight of engine and tender. The average speed of these trains is from 45 to 50 miles an hour. With a train of 140 tons, one of them has made the run from Paris to Amiens, 81 miles, in 90 minutes, or at the rate of 54 miles an hour; and with a train of 200 tons it has made the run from Paris to St. Quentin, 95 miles, in two hours, or at the rate of 47½ miles an hour. In their regular work they are frequently called on for exceptional speed where it is necessary to make up time on account of delays on connecting lines or other causes.

Among these exceptional performances are included a run at the rate of 43.5 miles an hour up a long grade of 0.8 per cent., the train weighing 140 tons, or 220 tons with engine and tender; a run at 46.6 miles an hour up a grade of 0.5 per cent., with a train of 225 tons, or 305 tons, including engine and tender; a run at 55.9 miles an hour on a level with a train of 210 tons—290 tons, including engine and tender.

Among the excellent points shown by these engines have been quickness in starting and in reaching full speed from a stop; great stability at high speeds, and an economy in fuel as compared with other engines doing the same work.



SECTIONS SHOWING HIGH-PRESSURE CYLINDERS.



SECTIONS SHOWING LOW-PRESSURE CYLINDERS.

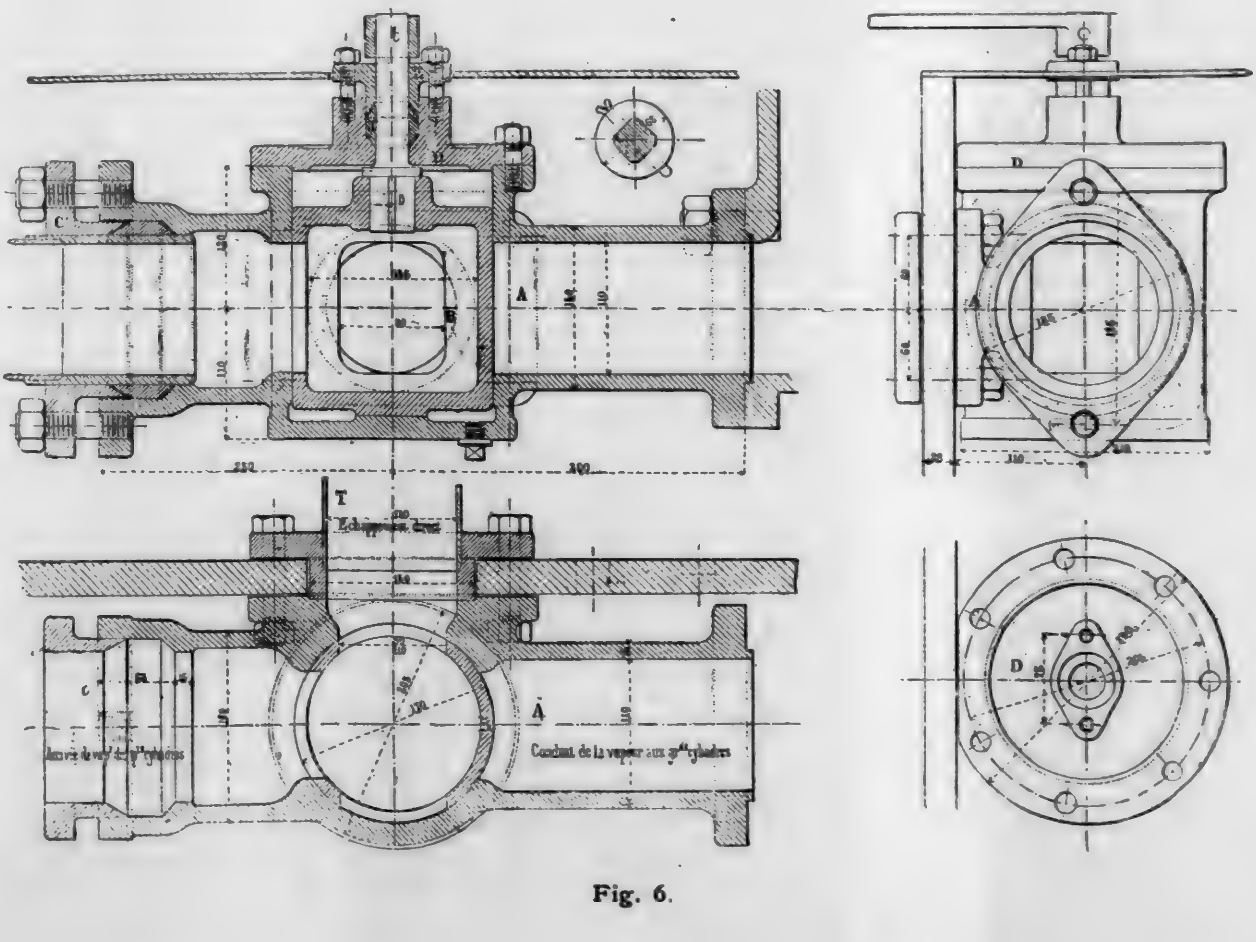
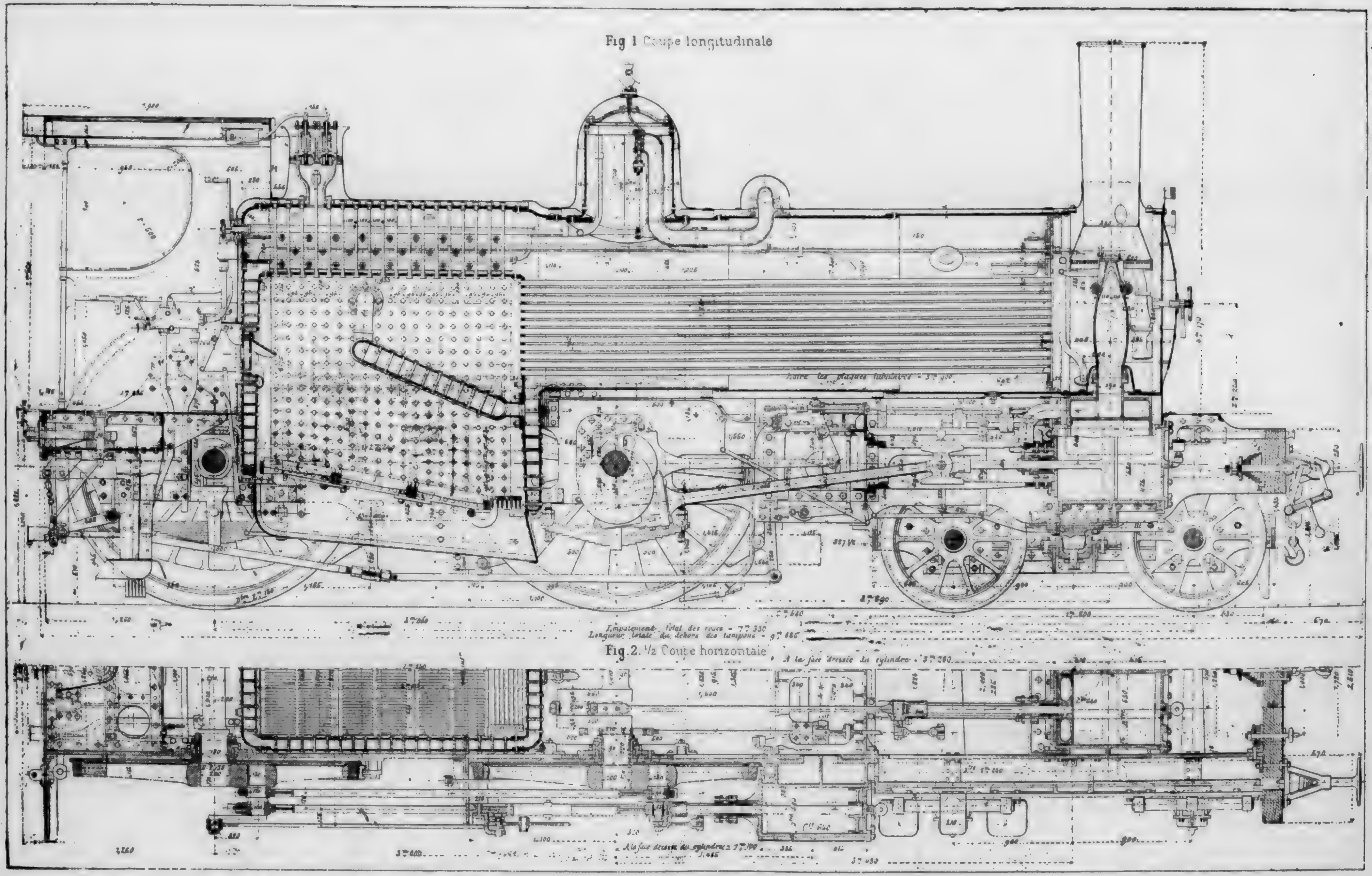


Fig. 6.



FOUR-CYLINDER COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE, NORTHERN RAILROAD OF FRANCE.

The fuel economy as shown by single trips has been over 23 per cent.; as shown by a much safer test—three months of regular work—it was 14.45 per cent. An economy which would hardly be looked for was a saving of some 10 per cent. in consumption of lubricating oil. It is stated that during the months of service every means were taken to see that the compound engines received only fair treatment and were not favored in any way.

The maximum tractive power when working compound is calculated at 17,295 lbs., which is increased to 22,040 lbs. when the high-pressure cylinders exhaust directly and all the cylinders are working separately. The maximum tractive power obtained in practice when working compound has been 11,174 lbs., or about 65 per cent. of the theoretical maximum.

To meet certain criticisms this engine was tried for several days with the parallel rods removed, so that the drivers were not coupled. The results were not favorable. While the same speed was attained, the engine lost in some degree its quickness in starting, and some slipping was noticed while running as well as in starting. The exhaust was not as even, and there was some irregularity in its pulsations; it was also less quiet, and it was evident that the engine worked better when coupled.

This engine of M. du Bousquet is in many respects a remarkable locomotive, and deserves careful attention. As a whole it certainly reflects credit on the designer.

THE NEW YORK AIR-BRAKE COMPANY'S WORKS.

As the early patents on air-brakes have nearly all expired, the business is now open to any one disposed to go into it. In the early days of their evolution Mr. Frederick W. Eames invented and manufactured a form of vacuum brake which was known by his name, and which is still used on some roads, among them the New York Elevated.

He established his manufactory at Watertown, N. Y. As some of our readers may have only an indefinite idea of the location of this place, it may be explained that it is in the northern part of the State, only a few miles east of the eastern end of Lake Ontario. It is located on Black River, which supplies a magnificent water power at this point to the brake works, and to a number of large paper-mills. The river has its headwaters about the middle of that portion of the State which is north of the New York Central Railroad. It flows northwestward and empties into the eastern end of Lake Ontario near Sackett's Harbor of historic fame. Watertown is one of the most beautiful places in the State. The dwelling-houses of the well-to-do people—of whom there seem to be a great many—are of exquisite design, and generally have ample grounds about them. The streets are well shaded, and with the yards and gardens form perfect pictures of sylvan beauty. The works are located on an island in the river about which the water tumbles and whirls in a way that is bewildering to a stranger, but fascinating, too, to a driver of a pen or pencil whose daily life is spent in the haunts which are known as "up-town" and "down-town" in New York City.

The works are under the management of Mr. Albert P. Massey, Mechanical Engineer; R. C. Augur, Assistant Mechanical Engineer; H. G. Manning, Superintendent; William H. Pollard, Assistant Superintendent; W. H. Ford, Chief Draftsman; and J. E. Stebbins, Specialist, the meaning of which latter title is that any special work which does not come under the jurisdiction of other departments is referred to him.

A plan of the works is shown by the diagram herewith. About 600 hands are employed, and the shops have a capacity for turning out a large amount of work. The largest of the group of buildings is the machine shop, which is built of brick, 41′ × 250′ and three stories high. The offices and drawing-rooms are in the south end of this building. The different shops have in all six elevators built by Morse & Williams of Philadelphia. With these all work is carried up and down to and from the different floors. All the shops are models of cleanliness, and ample provision is made for washing, closets for the men's attire, and water-closets for their necessities. These conveniences recall with a shudder the horrors and unutterable abominations which existed in machine shops 40 years ago, during the period when the writer acquired his "practical experience."

Some notes of the tools and appliances in these shops may be interesting. The driving power, as already remarked, is water, which, being unfailing, no engines are required. The parts of brake fixtures, compared with ordinary locomotive work, being small, nearly all the tools used in these shops are small and light. In much of the work, however, a very high degree of precision is required, and therefore the very best tools and appliances must be used.

In the machine shop there are, for example, such tools as the following: Seven Brown & Sharpe screw machines, on which brass work for valves of various kinds is done; six milling machines, some of them by Brown & Sharpe and some by Warner & Swasey, of Cleveland, O., and a milling machine for grinding packing rings for triple valves. These rings are made eccentric in form, and their sides must be ground so that they will be slightly thicker on their outer edges than they are on the inside. This requires very accurate work. Wet emery-wheels are used for grinding tools. A number of cock-boring and key-turning machines by Warner & Swasey are in use. Some of these have double heads arranged so that a cock may be bored with one of them, and a key turned simultaneously with the other. A monitor turret machine, by Warner & Swasey, is used for doing the lathe work on the main triple valves. Two three-spindle sensitive drills, by Dwight Slate Machine Co. of Hartford, Conn., are employed for drilling the minute holes which are required in some parts of the brake apparatus. Two special grinding machines, by Brown & Sharpe, used for grinding the cylinders for triple valves are interesting. The emery-wheel, of course, revolves rapidly and the cylinder slowly. At the same time the emery-wheel has a movement longitudinal to the cylinder equal to the stroke of its piston. By this means the insides of the cylinders are finished with the utmost precision. As this part of the brake apparatus is very delicate, the pistons, cylinders and valves must all be finished in the most exact way.

The valve-seats in the triple valve consist of a slot $\frac{7}{16}$ in. wide and $\frac{3}{16}$ in. deep, which is cut on the inside of a cylindrical surface. This is done by a machine which has a spindle $1\frac{1}{8}$ in. diameter and about 5 ft. long, with cutters on the under side of the width of the slot, and shaped somewhat like saw teeth. This spindle moves longitudinally to the valve-case, and in less time than it has taken to write this description cuts the slot in which the slide-valve works.

Another special machine is one for boring and tapping cocks. It has a three-jawed chuck, which holds one cock for boring and one for tapping, and while this is being done a cock is taken out of the third jaw and replaced with another, so that the operation is continuous. The boring tools are held in two spindles on each end which are thrown out by cams. Cocks are all tested by subjecting them to air-pressure below water. The escape of bubbles of air reveals any leakage.

No. 3 shop is devoted chiefly to vacuum brake work. This form of brake is still extensively used as an engine brake and on the cars of elevated railroads, in cities, and on foreign lines where it was introduced when it was first brought out.

A 36-in. boring-mill, by the Bridgeport Machine Tool Company, is used for finishing the center plates for pumps. Two Sellers double-shaft boring-mills are used for boring pump cylinders. Besides these there are 10 single-spindle boring mills, by the Newton Machine Tool Works, employed in boring brake cylinders. Among the other tools in use are two three-spindle drill presses, one four-spindle tapping machine, a two-spindle drilling and tapping machine. These machines are by Prentice Brothers, of Worcester, Mass.

The first floor of No. 3 shop is the assembly-room for air work, and the basement is also devoted to vacuum work. One of the processes required in this department is to saturate the cylinders and diaphragm cases in hot

paraffine to make them air-tight, as it is found that air will often leak through ordinary castings.

The tool-room is on the first floor of No. 1 shop. It is supplied with a No. 1 Brown & Sharpe universal grinding machine, two No. 3 universal cutter and reamer grinding machines, a twist drill grinder, made at the Worcester Institute of Technology, and all the other tools usually found in such departments.

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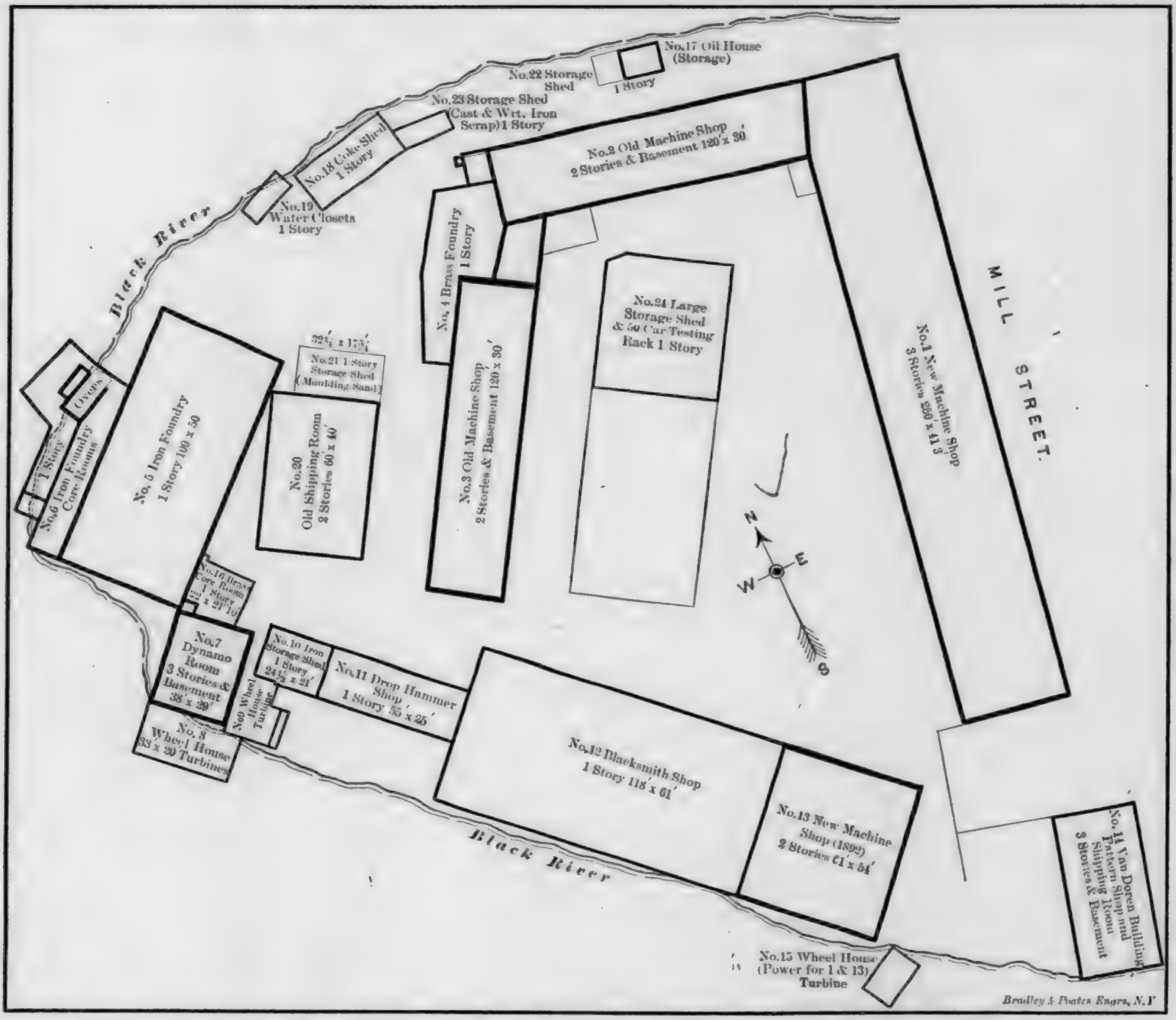

PLAN OF NEW YORK AIR BRAKE COMPANY'S WORKS, WATERTOWN, N. Y.

Ample iron and brass foundries and a blacksmith shop are also part of this establishment. In the latter considerable heavy work must be done for heavy locomotive brakes. A peculiarity in the blacksmith shop is working the power hammers with compressed air instead of steam. This air is compressed by water power.

In the manufacture of brake apparatus the utmost care must be taken in the inspection of it during the time it is being manufactured, and after it is completed. A defect in any part of the apparatus may, after it is put in service, mean failure, and failure may mean disaster. Therefore at every stage of the work the most rigid inspection is applied to all the parts which are turned out.

What is called a "Duplex" air-pump is used by the New York Air-Brake Company for compressing the air which operates the brakes. It has two steam and two air-cylinders. The two steam-cylinders are of the same size, and are placed side by side. The air-cylinders are of unequal size. Each of the steam-pistons is connected to

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The extent of this establishment and the perfection and capacity of its equipment was a surprise to the writer, as he believes it will be to many of his readers.

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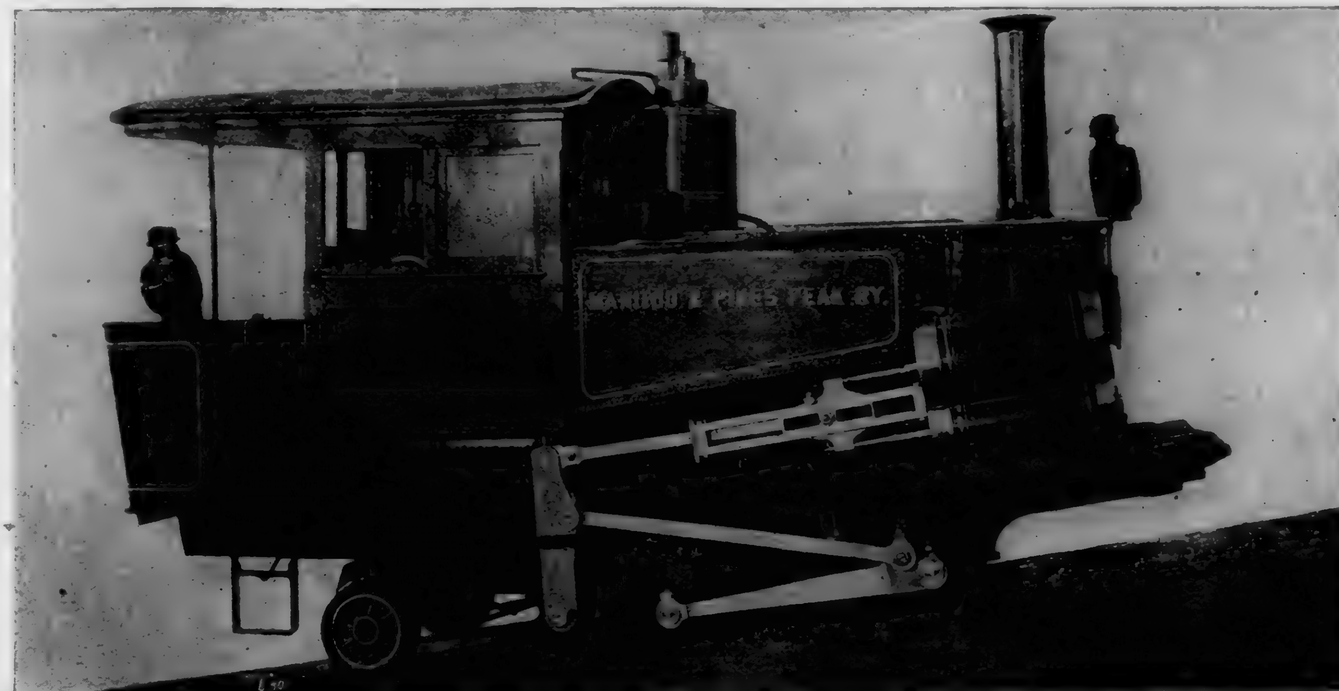
The boiler is set at an angle of about 10° with the track, in order to keep it nearly horizontal. The frames are outside, and are of the plate type. The rear pair of bearing-wheels are arranged in a two-wheeled truck.



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The boiler barrel is 46½ in. in diameter, and has 158 tubes 1½ in. in diameter and 7 ft. 3 in. long. The fire-box is 36⅝ in. long and 51⅝ in. wide, the outside frames permitting this unusual width. Water is carried in two side tanks, each holding 200 gallons. The coal-box is at the rear end of the cab. The total wheel base of the bearing-wheels is 11 ft. ⅛ in. The total weight of the engine in working order is 45,850 lbs., of which 33,200 lbs. are carried on the drivers.

The high-pressure cylinders are 9 in. in diameter and the low-pressure 15 in., both being 22 in. stroke. The valve gear is that ordinarily used in the Vauclain engine. The ratio of the cylinders is 1 : 2.78. The driving-axles are spaced 4 ft. 9⅝ in. between centers; the toothed driving-wheels are 22.468 in. in diameter, measured on the pitch line. The gauge of the bearing rails is the standard, 4 ft. 8½ in.

The engine is a neat and compact design and well adapted for its special work. An excellent feature is the adoption of the outside plate frame, giving fire-box room which could not otherwise be obtained without lengthening the boiler to an undesirable degree.

THE BHATGARH DAM.

FOR some years past English engineers have been engaged upon extensive works by which the waters of the Nira River, in India, are preserved and utilized for irrigation. In connection with these works it was found advisable to provide a large storage reservoir, and the spot selected was at Bhatgarh, where the Yelwandi River joins the Nira. The tributary stream brings down a large amount of water in the rainy season, and its valley above the junction is well adapted for a reservoir. The dam as planned and built is across the Yelwandi, just above its mouth, and is a work of considerable magnitude. For the description of the dam and the accompanying drawing we are indebted to the *Indian Engineer*.

The dam, which is of masonry and concrete, is 3,020 ft. long, with a maximum height of 127 ft. above lowest foundation and 103 ft. above the bed of the river, the width at full supply level being 12½ ft., and the maximum width at base 76 ft. Two waste weirs are provided, one at the south and one at the north end of the dam. A roadway with clear width of 11 ft. is constructed on the top of the dam and carried over the waste weirs by means of piers and arches. The combined length of the dam and weirs is 4,067 ft., the clear length of water way on the two weirs being 810 ft., calculated to discharge the maximum flood with a head of 8 ft.

Fifteen under-sluices are built in the dam, in the river portion, each 8 ft. × 4 ft., with their sills 12½ ft. above the bed of the river, and designed to carry off the early monsoon floods, which are heavily laden with silt. Two additional sluices to draw off the water at higher levels for the canal supply are built, one in the north and the other in the south flank, each 3 ft. × 3 ft., with their sills respectively 24 and 59 ft. above the sills of the under-sluices.

Seven turbine sluices, two on the right and five on the left bank, have also been provided, each 2½ ft. diameter.

The line of the dam crosses the river in a curve of 4,500 ft. radius convex to the water, the length of the curve being 2,300 ft.; it is continued on the north bank, in a line tangential to the curve, and on the south a reverse curve of 300 ft. radius for a length of 407 ft. brings the line to the ridge along which it is taken in a straight line tangential to the last curve, the length of 400 ft. at the south end giving an excellent site for a waste weir. The curved plan of the dam was adopted to suit the best line of foundation and not with any idea of giving additional strength. This form, however, adds considerably to the beauty of the structure, and gives an appearance of greater strength. A light railing 3 ft. high is provided on each side of the roadway along the top of the dam. It consists of cast-iron standards fixed in the parapets 10 ft. apart, and supporting a double line of wrought-iron piping.

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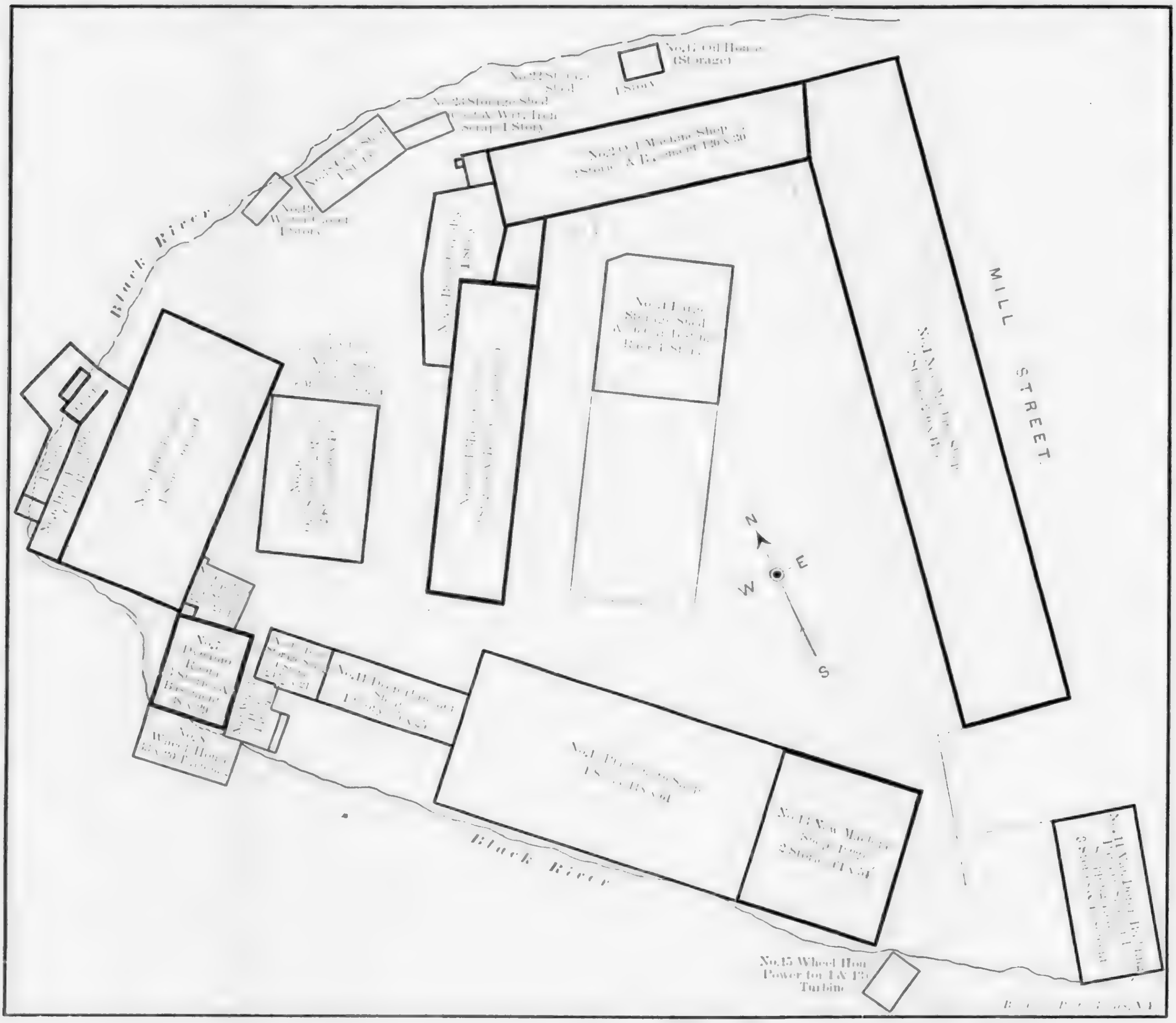

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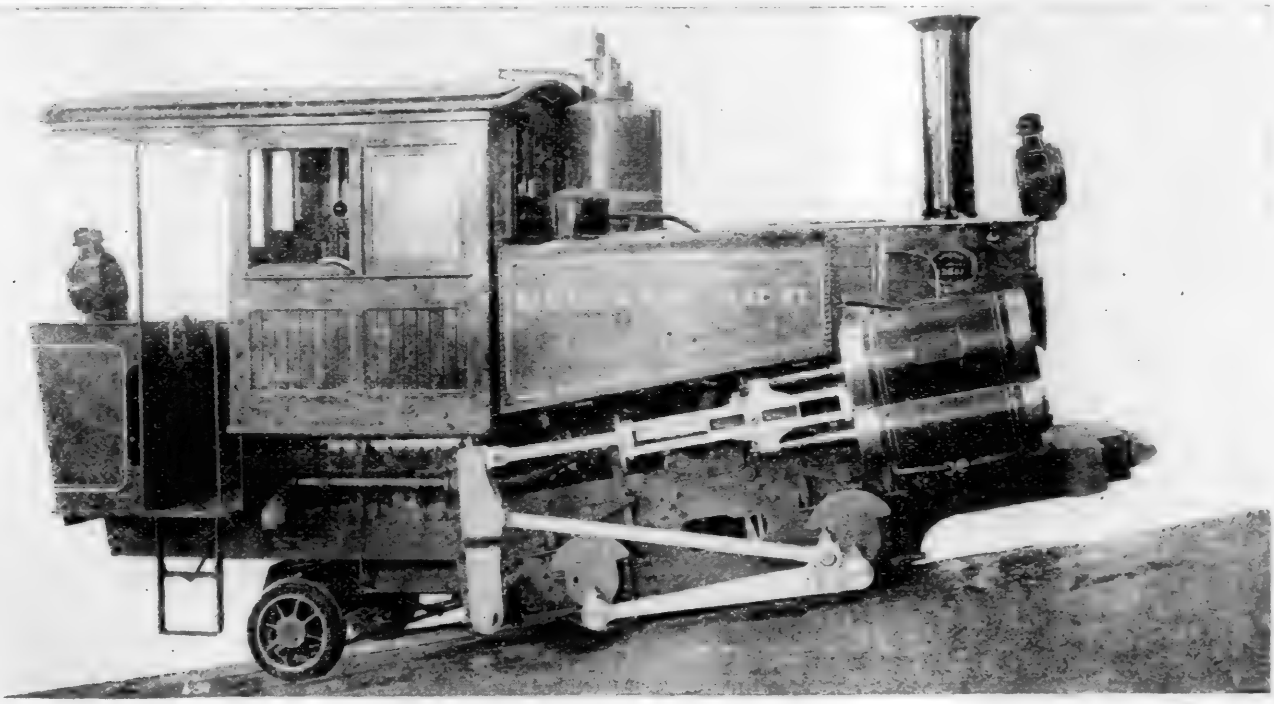

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Seven turbine sluices, two on the right and five on the left bank, have also been provided, each $2\frac{1}{2}$ ft. diameter.

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In the original design the section was calculated for a maximum height of 101 ft. with top width of 13.65 ft., bottom width, 67.64 ft., and the down stream profile in three straight batters. The dam was to be of rubble masonry, the weight of which was assumed in the calculation at 140 lbs. per cubic foot.

In 1883 the design was revised, and the conditions laid down were that the intensity of vertical pressure was to be nowhere more than 120 lbs. per sq. in.; that the resultant pressure was to fall within the middle third of the base of any portion of the section, and that the average weight of the material (rubble masonry and concrete) was to be taken at 160 lbs. per cubic foot. This weight was decided upon after a number of experiments with samples of the materials that it was proposed to use.

The water face of the dam which has been built has a batter of 1 in 50 and the profile of the down-stream face is a series of straight batters for every 10 ft. height, the general curve being a catenary. While the curve was adopted for the face of the dam, in practice it was found easier to build according to the designed straight batter and to check the width from a fixed setting-out line; the general appearance is a curve, as it is difficult to detect where the changes of batters occur. As a matter of curiosity, the profile has been checked by means of a chain, and it was found to correspond generally to the catenary, but this method could not be used with accuracy for building purposes. Looking at the section illustrated, it will be seen that on the up-stream side, at the sill level of the sluices, an increased width of 4 ft. is provided. This is to take the piers between the sluices to carry the lifting gear at the top of the dam, also to give room for the protective screens, and to provide a pathway to give access to the front of the sluices. The fact that the introduction of the openings for the under-sluices would intensify the pressure in the section between them also rendered an additional width advisable, and this was taken into consideration in the calculations. The section was worked out for a height of dam of 103 ft.; in those places in the river, where the extra depth of foundations produced a slightly greater height than this, the last batter, 9.3 in 10 was continued, and the first few courses at foundation level were laid somewhat in excess of the calculated width. The maximum pressure, 117 lbs. per sq. in., occurs at up-stream toe, reservoir empty. In this diagram two sets of figures are shown for the intensity of pressure at the down-stream edge of each sections. The upper figures on it are the results of the calculation by the ordinary method, and the lower denote the corresponding results arrived at by Bouvier's theory, the latter being considerably in excess of the former. The mortar used in the work is known to have a crushing strength, when one year old, of fully 700 lbs. on the sq. in.; therefore the factor of safety in the case of both calculations is very large.

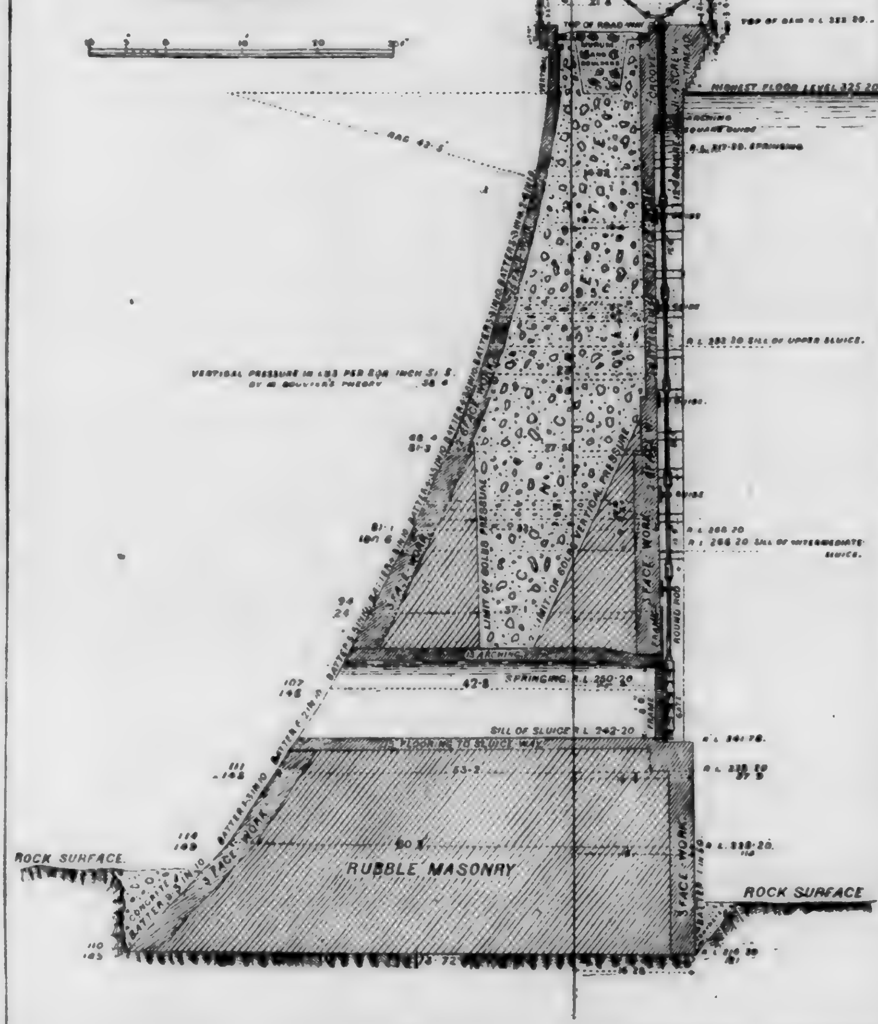
The final sanctioned section for the Bhatgarh Dam was designed, and all the calculations worked out by Mr. A. Hill, Assistant Engineer, under the orders of Mr. Whiting, the Executive Engineer.

The site selected was, in the first place, opened out as much as practicable along the whole length, so as to ascertain that sound rock was available everywhere, special caution being necessary in the river crossing, where there would be a heavy overfall from the under-sluices. The trial trenches which were carried deep into the rock in the river bed discovered the existence of a layer of basalt, about 12 ft. thick, overlying the trap and separated from it by a thin film of yellow clay. The rock itself was perfectly sound and of a most durable character, but as it was jointed and had not an even bearing on the rock below, it was decided to remove the whole of it. The quantity that had to be excavated was greater than anticipated, and in one place sound rock was only reached at a depth of 26 ft., giving a width of foundation of 74 ft. Close to the right bank of the river, the rock was found to exist in large cubes, separated from each other by joints of soft clay of varying thicknesses. Although the rock itself was of an excellent quality, the whole of the jointed mass was removed until perfectly sound rock was obtained for the full width of the foundation, which occurred at a depth of 50 ft. The founds were stepped up toward the south, and good rock was met with until close to the junction of the small reverse curve with the main curve of the dam, where it dropped suddenly and was replaced by a soft red rock. This had to be excavated for a depth of 30 ft. before a reliable foundation could be obtained; from this point to the end sound rock was found comparatively close to the surface. In the original design it was proposed to construct only one waste weir on the south bank, the length extending to the small reverse curve above referred to. The existence, however, of the soft red rock in this portion, where the overfall would have been very great, necessitated an alteration in the design, which has proved to be also a great improvement. The south weir was shortened so as to confine the overfall to the length where the founda-

THE NIRA CANAL

BHATGARH DAM.

CROSS SECTION.



tion was good, and a second waste weir was designed at the north end of the dam, where excellent rock existed. Increased waste weir accommodation was thus obtained, and it was possible to provide the full required number of automatic sluice gates on the north weir that would have been impracticable on the south.

No difficulty was experienced in obtaining good foundation on the left bank, except at one point in the site of the north waste weir, where the rock was much fissured. It was, therefore, decided to build up the waste weir at this point for a distance of 50 ft., to prevent any overfall on the rock that appeared to be not sufficiently sound to resist it. The dam, therefore, has been founded throughout on a rock base, about the strength and soundness of which there can be absolutely no doubt. Before commencing work, every foot of the foundation was carefully tested, and in most cases holes were drilled into the rock 3 or 4 ft. in depth, to be certain of its soundness. All levels and other information has been recorded on a foundation plan.

In the original design, it was proposed to construct the dam entirely of rubble masonry. The excellent results, however, obtained from experiments with sample of concrete used in the main weir at Vir, resulted in the substitution of concrete for rubble masonry in the hearting of the dam, with the object of reducing the cost of construction. The result of a series of experiments with blocks of concrete at Vir showed that the average crushing weight was 400 lbs. on the sq. in., and from similar experiments subsequently with the Bhatgarh concrete the result was an average of 375 lbs. on the sq. in. The proposal, therefore, was approved with the limiting condition that concrete was to be used where the pressure did not exceed 60 lbs. on the sq. in., and this method of construction has therefore been adopted.

The base of the dam, and where the pressure exceeds 60 lbs. on the sq. in., is built of uncoursed rubble masonry, between faces of hammer dressed block in course masonry of thickness varying from 3 ft. to 15 in., as shown in the section. In laying the foundations the rock at the down-stream toe was dressed throughout with a slope downward toward the center of the dam, and similarly at the up-stream toe it was dressed so as to be generally at right angles to the up-stream batter of face, of 1 in 50. The center portion, on which either rubble masonry or concrete was laid, was blasted out so as to present a rough base everywhere, as nearly as practicable at right angles to the resultant pressure. The space between the side of the excavation for founds and masonry face on the down-stream side was all carefully filled with concrete up to the surface level of hard rock. In order to pass off the river discharge, during the construction of the lower portion of the work, a working sluice was built through the dam with its sill at river bed level. This sluice or culvert is 4 ft. wide with a semicircular arch and total height of 7 ft. When no longer required it was built up for a distance of 16 ft. from the up-stream face. This portion of the sluice was built 1 ft. wider than the remainder, and with stones projecting 6 in. so as to secure proper bond. A 4-in. pipe with sluice at down-stream end was also laid in this 16 ft. of wall to pass off leakage from the mouth of the sluice which was temporarily blocked up during construction. The portion of culvert on the down-stream side remains open, and will be used to give access to the bottom of a small shaft 8 in. square, that has been built from the roof of the culvert vertically to the top of the dam. It is proposed to test the deflection of the dam by means of a plumb bob in this shaft, observations being taken when the reservoir is empty and afterward with the full water-pressure. The discharge, however, through the under-sluices during three seasons has resulted in the formation of a heavy bank of gravel and bowlders about 50 ft. from the dam, and a pool of water which completely covers up the working sluice; it will therefore probably be advisable to construct a small well up to river-bed level, with the double object of providing a water cushion or basin to protect the founds, and from which loose bowlders can be excluded, and also from which the water can be pumped to give access to the culvert, to carry out the observations for deflection.

The work was begun in July, 1881. By the end of June, 1891, the whole of the main dam was completed with the exception of the top layer of the parapets, the hand railing and road. The south waste weir was built up to within 9 in. and the north weir up to the finished crest level. The cubic contents of the dam and waste weir, when complete, will be 4,657,032 cub. ft., of which 1,512,802 cub. ft. are rubble masonry; 638,256 cub. ft. face-work and 2,505,974 cub. ft. concrete. The total cost is about $304,000.

There has been much controversy about the arrangement of the under-sluices, and some high authorities have condemned their use, while others have approved them. In their favor it was urged that they would prevent the deposit of silt by the scouring produced when they were open.

The clear opening of these sluices is 8 ft. high and 4 ft. wide; each gate of cast iron with its steel lifting rod 4½ in. in diameter weighs about 4½ tons. The top length of the lifting rod is square in section for a length of 12 ft. 6 in., machined on all sides, to work in a square guide also planed true. The top 11 ft. 4 in. of the rod is screwed, and on it fits a gun-metal nut and collar which fits in a cast-iron thrust box, bolted to the masonry at the top of the dam. A cast-iron capstan head fits the nut, and is worked by six wrought-iron arms, the end portions of which are bent so as to be horizontal at a suitable height above ground level. Additional leverage can be obtained by means of wrought-iron piping slipped over the ends of the bars. The screen in front of each gate consists of wrought-iron double-headed rails 2½ ft. from the face of the sluice weighing 66 lbs. to the yard, fixed in horizontal rows 1 ft. apart, the ends resting in grooves in the block in course masonry piers, and kept in position by vertical bars 1¼ in. in diameter. The calculated maximum velocity through the sluices is 60 ft. a second, and it is estimated that the greatest probable pressure on each rail will be less than one-third of the safe load, and one-fifteenth of the breaking load; the margin of safety is therefore very large. The only defect to be noted in the design is the position of the cage of rails with respect to the sluice. It should have been at least 12 ft. in front instead of only 2½ ft. This could have been done at some extra expense by prolonging the piers up-stream, and the cage at this distance would have minimized the danger of brushwood interfering with the working of the gate. The gates with the lifting rods, excepting the top screw length, were constructed by Messrs. Richardson & Cruddas, of Bombay, each gate being carefully tested. The two sluices for drawing off water for irrigation are each 3 ft. square and similar in design to the under-sluices. A great mistake was, however, made in these two gates by providing brass facing on the gate only, the frames on which they work being only planed cast iron. The result in two seasons is that the faces of the frames are pitted by rust, and there is no doubt that eventually brass-faced frames will have to be substituted.

The weir is divided into two portions, one in the north, the other at the south end of the dam, and in order to accommodate the road over the dam, both weirs are crossed by means of piers and arches, the clear width between piers being 10 ft. The number of openings on the north is 45 and on the south is 36, the maximum depth of discharge allowed above crest being 8 ft. The calculated discharge is 56,457 cub. ft. per second, which is in excess of the greatest known flood. The weir openings can be closed by sluice gates when required.

THE UNITED STATES NAVY.

THE difference of opinion between the Senate and the House on the Naval Appropriation Bill has resulted in the adoption by a Conference Committee of a compromise report. It will be remembered that the House bill, as originally reported and adopted, provided for only one new ship, an armored cruiser of the same class as the *New York*. To this the Senate added a battle-ship, several gunboats, and a number of torpedo-boats. By the conference report the gun-boats and the torpedo-boats are

dropped and the Appropriation Bill will authorize the beginning of work on the new cruiser and one battle-ship. The plans for the latter have not been adopted, but it is understood that the new vessel will be somewhat similar to the *Indiana*, *Massachusetts*, and *Oregon*, which are already under construction.

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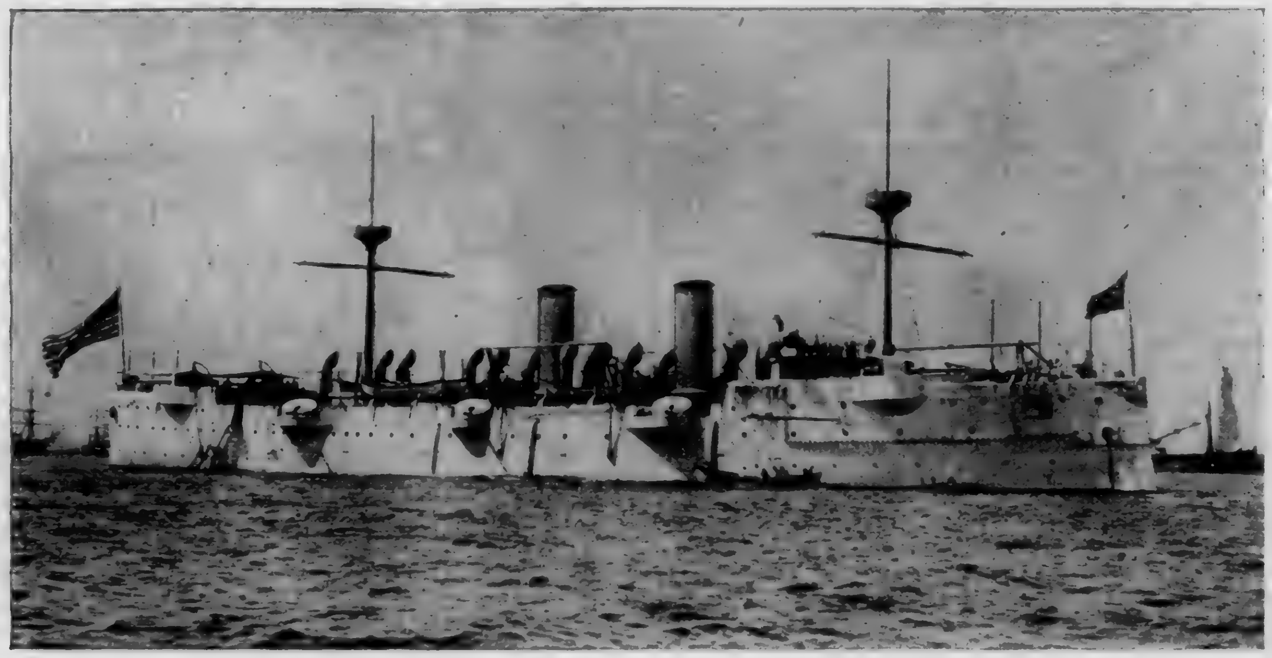
Each screw is driven by an independent horizontal triple-expansion engine. These engines have developed 10,750 H.P., and have given a speed of 20.2 knots. There are eight double-ended cylindrical boilers arranged in groups of four. The full coal capacity is 900 tons, giving a radius of movement of 3,400 knots at full speed, and of 12,000 knots at a 10-knot speed.



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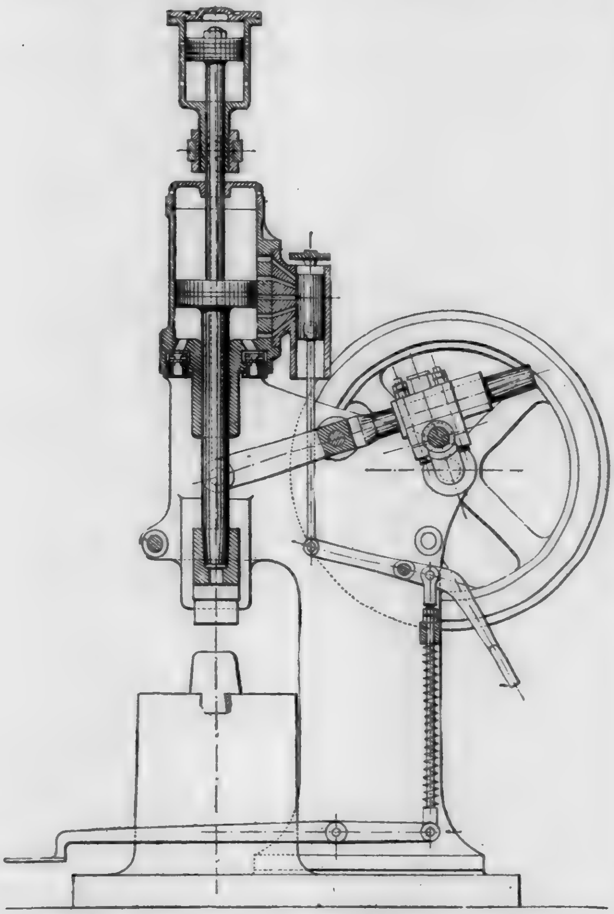
THE accompanying illustration represents one of several varieties of the Longworth power hammer, now being manufactured by Samuelson & Company, Banbury. It will be seen that these hammers possess several novel and important features, which render them applicable to many

classes of work which could not hitherto be done by power hammers, as, for instance, the arrangement of the patent controlling cylinder and valve, whereby by means of one foot or hand lever single blows, light or heavy, can be instantaneously given, or a repetition of light or heavy blows immediately delivered, or the hammer made to stop up at once quite clear of the work on the anvil. Referring to the drawings of the forging hammer, we find that the hammer is actuated by a driving belt pulley and crank-shaft, the crank-shaft giving motion to a rocking lever, which, by means of long links and a crosshead, recipro-



THE LONGWORTH POWER HAMMER.

cates the top or actuating cylinder in a vertical direction, with little or no lateral strain, the cylinder being guided solely by its own piston and hammer-rod. The top cylinder acts upon the piston by means of the air cushions formed by the air enclosed at each end of the cylinder, so that reciprocating motion is communicated to the hammer without any knock or jar being transferred to the driving mechanism. The position occupied by the top cylinder enables it to be made large in diameter, and capable of being raised or lowered by the nuts on the crosshead; it is also free to turn round upon the hammer-rod.

The above mechanism is all that is required to give a repetition of blows with uniform force, but to vary and also to have perfect control of the blow, a fixed controlling cylinder attached to the framing of the machine is necessary. The controlling cylinder is furnished with self-acting inlet valves at bottom and outlet holes or ports at the side, the latter being closed or opened by a piston slide-valve, which is placed under the control of the foot or hand of the workman. The upper part of the cylinder is, by means of suitable openings, practically open to the atmosphere.

A piston attached to the hammer-rod works in this cylinder, and, as the hammer rises, air is drawn through the inlet-valves into the lower part of the cylinder. If now the hammer descends, and all the outlet holes are closed by the slide-valve, the air is compressed by the piston and forms a powerful cushion, sufficient not only to absorb the momentum of the blow, but to keep the hammer faces at a considerable distance apart; and as the power absorbed by the cushion of air in the down-stroke is given back to the hammer in the up-stroke, little power is required to keep the hammer working in this way, and in proportion as this opposing cushion of air is decreased, the force of the blow and the power to drive the hammer is increased, so that less power is required to drive the hammer when giving a light blow than when giving a heavy one.

As the slide-valve is lowered, thus opening the outlet holes one after the other, various degrees of cushioning are obtained, and therefore various forces of blows given, from a blow light enough to delicately touch the work, to the heaviest blow the hammer is capable of giving. By quickly lowering and raising the slide-valve a single blow can be delivered of any required force, the hammer faces keeping apart as before after each blow; and on holding the slide-valve in any desired position uniform blows can be given, or a force corresponding always with that position. The great efficiency and uniformity of the result obtained by the above system is owing to the fact that the commencing point of cushioning, or cut-off of the exit of the air, is made to take place at definite points in the length of the downward stroke of the hammer.

As the hammers described are made in sizes as light as 10 lbs. for planishing and as heavy as 10 cwt. for forging, and can be run at speeds from 500 to 50 blows per minute, they are well suited for a great variety of work.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

BY A. ZDZIARSKI, C.E.

ONE of the most important problems of railroad location is the selection of suitable crossings of great rivers and an exact determination of the necessary clear openings to be made in designing these bridges. A careful study of this problem may be of great economical advantage, the cost of bridges being very high, and increasing with their length. Indeed, when a mile of railroad can be constructed for \$25,000 to \$50,000, a permanent bridge of one mile length will cost \$2,500,000 to \$5,000,000, or 100 times more.

In English and American technical literature it is difficult to find any full answer to the above questions; the same can be said of the literature of the European Continent, where great rivers do not occur—the Rhine and the Danube perhaps excepted. On the contrary, the great rivers of Russia and Siberia required that the problem of accurately determining the spans of bridges across them be studied carefully. The result of these studies I present in the following article, which contains the rules and practice adopted in Russia for the location of great bridges and the determining of their clear spans.

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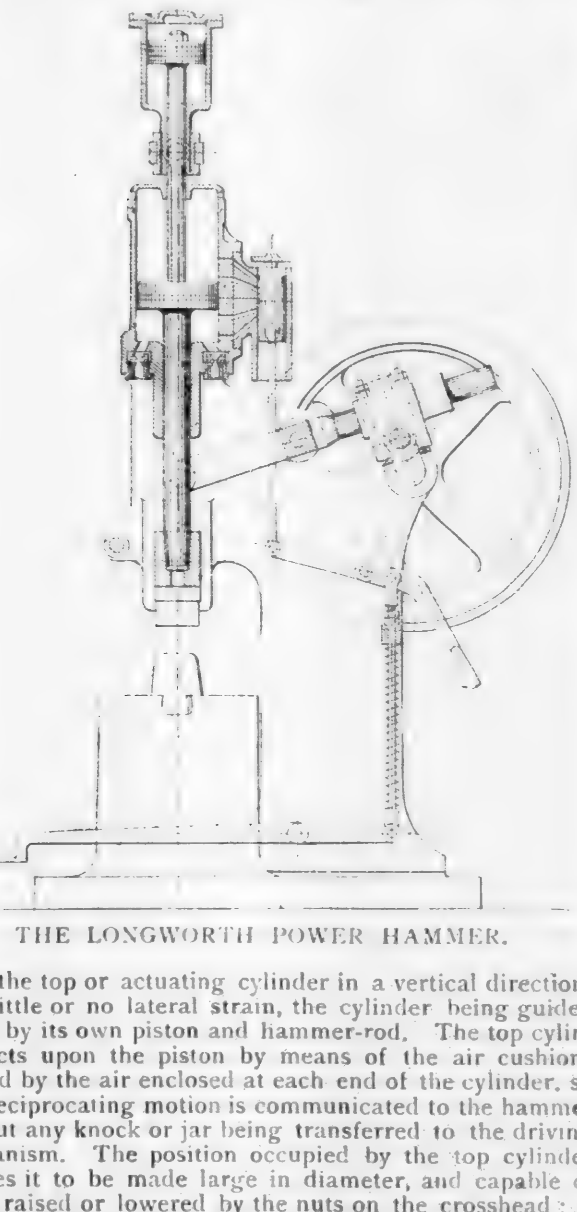

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II.—PRELIMINARY RECONNAISSANCE AND CHOICE OF A SUITABLE PORTION OF THE RIVER.

Before the beginning of the detailed examination of the river crossing, it is necessary to make a reconnaissance of it, particularly in order to chose: (1) The site for the bridge, and (2) the portion of the river suitable for the measuring and determining the discharge.

The site for the bridge should be so selected that the railroad line (the axis of the bridge) may be as nearly as possible perpendicular or normal to the direction of the current, and that the direction of the high-water current be not very different from the low-water current.

The portion of the river chosen for the purpose of measuring the discharge of water can be either at the site of the bridge or somewhat above or below it; but this portion must satisfy the following requirements: It should be nearly straight, and have a length at least equal to double the width of the river; it should have at its ends neither banks, shallows, nor sharp curves; the cross-sections should have regular outlines and an ordinary width, and moderate and uniform depths; the banks should be, if possible, not inundated.

III.—THE WATER GAUGE.

After a suitable portion of the river is chosen, there should be established there one or two water gauges (if two, one on each bank of the river) in a spot convenient for observations, and secured from running ice. The zero point of the gauge should be connected with the general level of the railroad line.

The water-gauge indications should be registered three times every day—say at 8 A.M., 1 M. and 9 P.M. Besides these sudden rises or falls of water, occasional floods and the levels of spring and autumn ice runs or floods should be exactly registrated.

IV.—DETERMINING THE MAXIMUM DISCHARGE OF WATER IN THE RIVER.

We do not need to repeat that the knowledge of the maximum discharge of water in the river is necessary for calculation of the minimum clear span of the bridge to be thrown across that river.

It is obvious that this maximum discharge corresponds to the highest level of the water; but as it is usually not probable that this highest level could be met at the time of the observations, therefore this maximum discharge can be only deduced by means of calculations based on data which may be furnished by immediate observations. For these calculations we propose two methods.

1. *The first method* (till now generally used) can be stated as follows:

The discharge corresponding to the highest observed level is immediately determined by means of measurements of the cross-sections and velocities; then from this discharge Q and the area of the cross section w is calculated the mean velocity $u = \frac{Q}{w}$. Besides this, the local slope i of the river is determined by taking the water-level for at least two miles along the shores. Then adopting one of the empiric formulas, giving the value of the mean velocity in terms of the slope i, the mean depth R (which is equal to the area of cross section divided by the width b of the river—viz., $\frac{w}{b}$), compare the measured value of the mean velocity u with the values calculated from one of the formulas $u = \int (R\, i)$, and select the formula which, for this case, gives the most available results; if necessary, change in that formula the numeric coefficients so that the calculated value of velocity coincides with the measured value immediately determined from observations.

From the empiric formulas giving the mean velocity in terms of slope and mean depth of water, we can recommend the following (all quantities given in meters):

The formula of Humphreys & Abbot, the formula of Grebenau, the formula of Darcy-Bazin, and the formula of Ganguillet & Kutter.

In all the formulas we will adopt the following notations:

u = mean velocity of current.
w = area of cross section.
p = length of wetted perimeter.
b = width of river.

$$R = \text{hydraulic mean depth } \frac{w}{b}.$$

$$r = \text{mean radius} = \frac{w}{p+b}, \text{ approximately} = \frac{w}{2b} = \frac{R}{2}.$$

$$i = \text{slope of river} = \frac{\text{fall}}{\text{length}}.$$

1. The American formula of Humphreys & Abbot, deduced from experiments on the Mississippi, is the following, in meters:

$$u = \left(\sqrt{0.0025\, m + \sqrt{68.72\, r\sqrt{i}}} - 0.05\sqrt{m}\right)^2$$

where

$$m = \frac{0.933}{\sqrt{R + 0.457}}.$$

The values of the coefficient m are the following:

$R = 4.5 - 3.5$	2.2	1.4	0.2 meters
$m =$ 0.18	0.58	1.07	1.10.

The same formula, in feet, has the form

$$u = \left(\sqrt{0.0081\, m + \sqrt{225\, r\sqrt{i}}} - 0.09\sqrt{m}\right)^2$$

$$m = \frac{1.69}{\sqrt{R + 1.5}}.$$

2. The formula of Grebenau, based on the experiments on the Mississippi and other rivers, is in (meters):

$$u = 8.29\, \beta \sqrt{r\sqrt{i}},$$

where β depends upon the dimensions of river—viz:

for $w = 20 - 400$ sq. meters, $\beta = 0.9223$,
$w > 400$ " " $\beta = 0.9459$.

For the great rivers, $r = \frac{w}{p+b} = \frac{w}{2b} = \frac{R}{2}$, and the formula of Grebenau has the form

$$u = 8.29 \times 0.707\, \beta \sqrt{R\sqrt{i}},$$
$$= 5.861.\, \beta . \sqrt{R\sqrt{i}}.$$

We can observe that the formulas of Humphreys & Abbot, and of Grebenau can be successfully applied only to great rivers with a slope less than 0.0001.

3. The formula of Darcy-Bazin is (in meters):

$$u = \sqrt{\frac{1}{\alpha + \frac{\beta}{R}}}\sqrt{R\, i},$$

where for earth bed

$$\alpha = 0.00028 \qquad \beta = 0.0003500,$$

and for rivers sweeping over coarse sediment

$$\alpha = 0.0004 \qquad \beta = 0.0007.$$

We can observe that this formula cannot be applied to rivers with a very small slope.

4. The formula of Ganguillet & Kutter is

$$u = \frac{23 + \frac{1}{n} + \frac{0.00155}{i}}{1 + \left(23 + \frac{0.00155}{i}\right)\frac{n}{\sqrt{R}}}\sqrt{\;i},$$

where n depends upon the kind of bed, being for

rocky bed	$n = 0.017$	$\frac{1}{n} = 59$,
earth "	0.025	40,
gravel "	0.030	33.

For the value of mean depth $R < 6$ meters, this formula gives the values of velocity about the same as the formula of Darcy-Bazin, which is much more simple; only for the greater values of R, this formula gives results which are better and more coincident with observations than the formula of Darcy-Bazin.

As above said, the value of mean velocity calculated by means of these formulas should be compared with the value immediately determined by observation, and that formula should be chosen which gives the most nearly coincident value. These formulas, with some corrected coefficients (if necessary), should be adopted for calculation of the maximum discharge.

This maximum discharge will be defined as the product of the maximum area of cross-section, and the calculated mean velocity corresponding to the highest level of water. The maximum area of cross-section is computed from the transversal profile of the cross-section of river-bed and its banks, obtained by leveling; the corresponding mean depth is deduced from the same area of cross-section, and the slope of high water is supposed to be equal to the leveled slope of the observed depth of water.

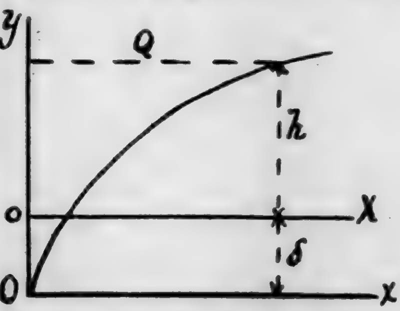
Observation. In applying the above empiric formulas, great care must be advised, this application being based on the measurement of the local slope, which is a very variable quantity. Indeed, it is stated that (1) in the same spot the slope is greater during the rise of the water than during its fall; (2) the slope of high water can be greater or less than the slope of low water, according to the form of the valley; (3) generally the slopes in narrow portions of the river are greater than in the neighboring wider stretches, etc.

II. The *second* method of determining the maximum discharge of water in rivers consists in the immediate determination or measuring of discharges corresponding to different (2, 3 or 4) levels of water in the same cross-section of the river; from this data will be deduced a formula giving the value of discharge in terms of the height of water (or water-gauge indications) for each level of water, and consequently also for the level of the highest water.

This method was deduced from many experiments made on the Saale and the Unstrutt, in Germany, and verified by the experiments on the rivers Soukhona and North Dwina, in Russia. It was also applied for the determination of the length of clear spans of bridges over the great Siberian rivers Irtish and Obi during the location of the Western Siberian Railroad in 1891 and 1892.

After having, for a chosen cross-section, determined 2, 3 or 4 values of discharge corresponding to different levels of water, we can draw a diagram in which the discharges will be the abscissæ, and the heights of water level the ordinates of a curve, expressing the relation between the discharge and the height of water level (fig. 1).

FIG. 1.



This curve may be considered as a parabola; and if we call the water-gauge indications h the corresponding discharge by Q, the ordinate of the parabola's summit by δ, and the parabola's parameter by p, then the equation of the parabola will be

$$h + \delta = \sqrt{p}\,\sqrt{Q}.$$

In order to determine the constants δ and $\sqrt{p}$, it is sufficient to have two observations of discharge; but for the sake of complete and secure results, it is better to make three or four observations in each section, and then the values of δ and $\sqrt{p}$ can be calculated according to the method of least squares; it is by formula

$$\sqrt{p} = \frac{n\,\Sigma\,(h\,\sqrt{Q}) - \Sigma\,\sqrt{Q}\,\Sigma\,h}{n\,\Sigma\,Q - (\Sigma\,\sqrt{Q})^2},$$

$$\delta = \frac{\Sigma\,h\,\Sigma\,Q - \Sigma\,\sqrt{Q}\,\Sigma\,(h\,\sqrt{Q})}{n\,\Sigma\,Q - (\Sigma\,\sqrt{Q})^2},$$

where n is the number of observations, or of different values of Q and h, and Σ the sign of sum.

Having so calculated for a given section the values of $\sqrt{p}$ and δ, we will have for the maximum value of Q, corresponding to the highest level H, the equation

$$H + \delta = \sqrt{p}\,\sqrt{Q},$$

whence this maximum discharge Q is

$$Q = \frac{(H + \delta)^2}{p}.$$

V.—THE IMMEDIATE DETERMINATION OF DISCHARGE.

As above said, in order to calculate the maximum discharge of water in a river it is necessary to determine immediately several different values of discharge corresponding to different heights of water level—say high, middle and low.

All these determinations of discharge should be made in the portion of the river previously chosen for this purpose, and besides them in the cross-section corresponding to the site of bridge. In the chosen portion of the river, the determination of discharge should be made in three sections normal to the direction of the current and situated from 300 to 600 ft. apart. The determination of discharge in the cross-section corresponding to the bridge is not so important, and if this cross-section is very irregular, divided by islands or shallows, then it can be set aside altogether.

In order to secure the perpendicularity of cross-sections to the direction of the current, the latter must be, if possible, exactly determined. For that purpose, in calm weather a small boat with one observer is driven in different places of the river, and in such manner that following the current he shall cross all the sections previously selected, which should be duly designated by means of posts driven on the shore. Another observer, with a theodolite, or transit, or a surveyor's table, follows the movement of the boat. When the boat enters the line of one of the preliminary sections, the observer in it makes a sign by means of a flag, and at the same time the observer on shore measures the angle or draws the direction on the table, and the position of the boat is determined. The consecutive positions of the boat give the line and direction of the current, perpendicular to which the definitive sections should be drawn.

If the character of the river is such that the portion of it selected for the measurements of discharge is far from the line of the bridge crossing—because the bridge can of course cross the river in a spot not suitable for the ac-

Fig. 2.

curate measurement of the discharge—then the determination of this discharge should be chiefly based on measurements performed in this regular portion of the river, and the cross-section corresponding to the bridge should be only exactly calculated by sounding the channel and leveling the shores.

The determination of discharge in the cross-sections chosen for that purpose should be made in the following manner: Divide the cross-section of the river bed by means of equidistant verticals into a given number of trapezes—a, b, c . . . h (fig. 2)—determine for each vertical the average velocity of water v, and supposing that this average velocity in the vertical is equal to the mean velocity of the water flowing between the verticals drawn at the centers of the neighboring trapezes, calculate the discharge Q as the sum of the partial areas of the cross-sec-

tion multiplied by the corresponding mean velocities—viz. :

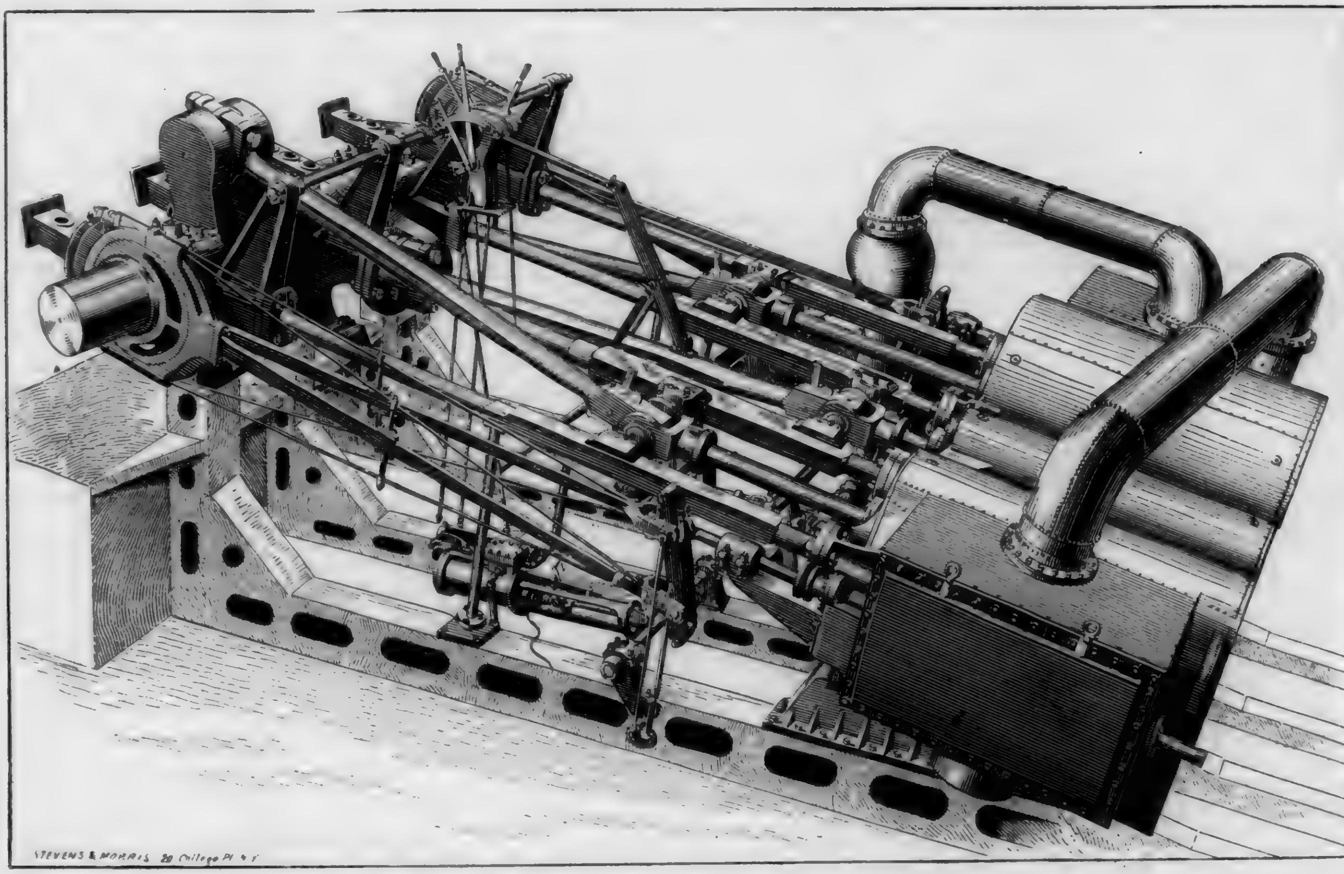
$$Q = \left(a + \frac{b}{2}\right) v_{ab} + \frac{b + c}{2} v_{bc} + \ldots + \left(\frac{g}{2} + h\right) v_{gh}.$$

(TO BE CONTINUED.)

A NEW TYPE OF SIDE-WHEEL ENGINES.

THE illustration given herewith is from a photograph of the engine recently built by the Cleveland Ship Building Company, Cleveland, O., for the side-wheel passenger steamboat *City of Toledo*. This engine is believed to be the first inclined triple-expansion three-crank engine built of steel castings. The air-pump is operated independent of the main engine, and is of the duplex type, having 14-in. steam-cylinders, 20-in. air-cylinders, and 20 in. stroke. The wheels are of the feathering type, 19½ ft. outside of the floats, which are of steel 9½ ft. wide, there being nine to each wheel. The manner devised by the engine-builders for supporting the engine in the hull is noteworthy from the fact that there is a total absence of vibration, even when running at highest speed. This is indicated in the engraving, and has been accomplished by a judicious combination of partial horizontal and vertical bulkheads.

Two boilers 10 ft. 10 in. diameter by 21 ft. long, of the gun-boat type, furnish steam at 160 lbs. pressure. Each boiler has three 46-in. furnaces, and they are run with natural draft. On trial these engines have developed 1,641 indicated H. P., running at 40 revolutions per minute.



TRIPLE-EXPANSION ENGINE FOR SIDE-WHEEL STEAMER "CITY OF TOLEDO."

BUILT BY THE CLEVELAND SHIP BUILDING COMPANY, CLEVELAND, OHIO.

in this country; the builders certainly deserve credit for making a very compact and serviceable engine, which is well adapted for a high-speed side-wheel boat, takes up much less room, and can be better placed in the ship than any of the engines heretofore in general use.

The *City of Toledo* was built for the passenger business between Toledo and the Lake Erie islands, which is very large in summer; she is 210 ft. long, 32 ft. beam and 12½ ft. molded depth. Her hull is of steel and the passenger accommodations are excellent. The boilers and machinery being all below the main deck, and the wheels not rising above the promenade deck, there is an unusual space available, and full advantage has been taken of it in fitting her up.

The engine, which is shown in position, has cylinders 26, 42 and 66 in. diameter by 72 in. stroke. The high-pressure cylinder is placed between the intermediate and low-pressure cylinders, and has a piston-valve actuated by a Joy radial valve-gear; the intermediate and low-pressure cylinders have double-ported slide-valves and ordinary link-motion. The steam-pistons are made very deep and have a special arrangement for taking up wear; the piston-rods are of steel; connecting-rods, guides, shafts and crank-pins of scrap-iron forgings; and cranks

A feature of this type of engine is the very small amount of space taken up on the main deck, being merely room for the cranks to turn, and for operating platform back of cranks. Ventilating trunks only are run up through the upper deck.

Mr. A. Angstrom, of the Cleveland Ship Building Company, is the designer of the engines.

The contract speed of the *City of Toledo* was 16 miles an hour; but she has exceeded that, having put on record a run of 16 miles in 47 minutes, or at the rate of 20.4 miles an hour.

THE LOCOMOTIVE PROBLEM AGAIN.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Four answers to this problem were received and published in the July number, without comment. The following additional answer has since been received :

V.—BY EDWARD WALKER, NEW YORK.

The answers to the Locomotive Problem published in the July number of the JOURNAL do not seem to be quite correct. Nos. I, II and III are incorrect ; and No. IV, though correct scientifically, is unnecessarily complicated, and its assumption that the connecting-rod is 8 ft. long is not in accordance with practice.

The speed of the piston and cylinder is 88 ft. per second ; to or from this must be added or subtracted the

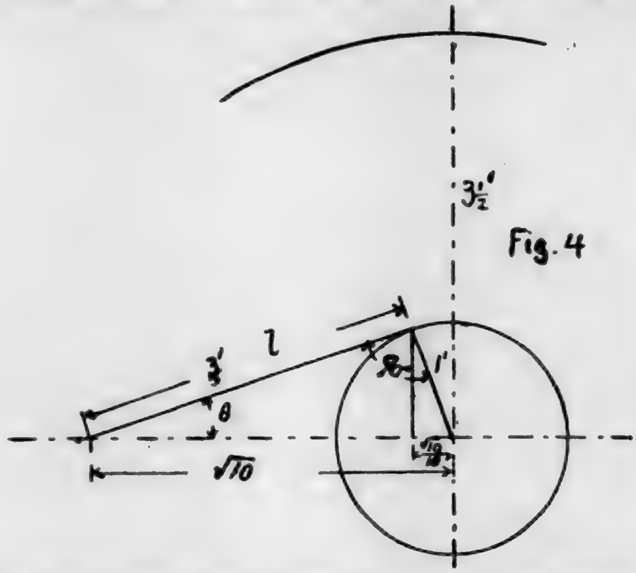


Fig. 4

maximum speed of the piston relatively to the cylinder. The greatest speed of the piston is when the connecting-rod is at right angles with the radius at the crank-pin, and its speed is then $= cos.\ \theta \times$ speed of crank-pin. The speed of the crank-pin is $88 \times \frac{2}{7}$, and the speed of the piston is $\frac{88 \times 2}{7}\ cos.\ \theta$. The value of θ depends on the length of the connecting-rod. I suppose 3 ft. would be a good average for 2 ft. stroke. The maximum and minimum speed of the piston relatively to the earth would then be 111.85 ft. per second and 64.15 ft. per second respectively.

The position in the stroke where this maximum and minimum speed occurs is at

$$1' \times sin.\ \theta = \frac{1}{\sqrt{10}},\ \text{or,}\ \frac{\sqrt{10}}{10} = 0.316$$

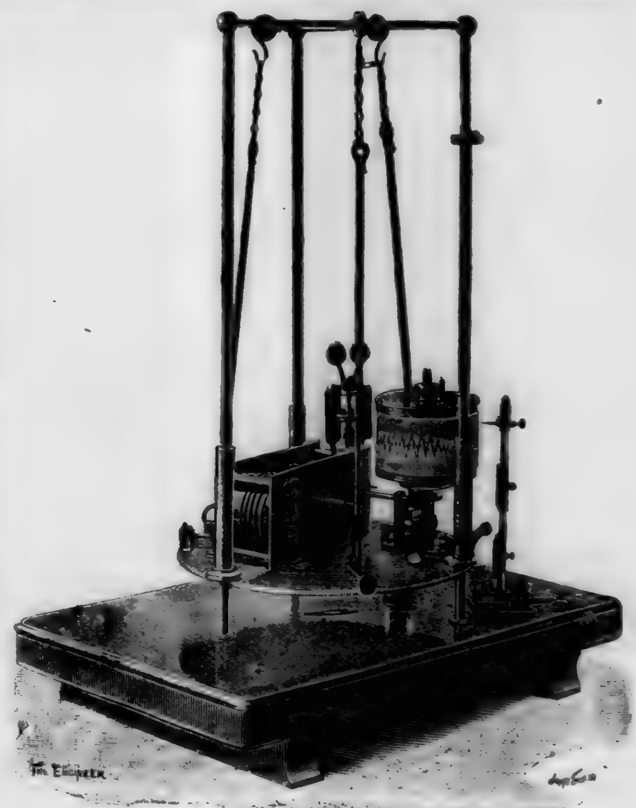
to the left hand of the stroke in fig. 4.

BALANCING MARINE ENGINES AND THE VIBRATION OF VESSELS.

(Paper read by Mr. A. F. Yarrow before the Institution of Naval Architects ; from the London *Engineer*.)

ALL who are acquainted with the working of steamers provided with large power and of high speed, such as torpedo-boats, torpedo-boat catchers, and very fast passenger steamers, will be familiar with the fact that they are subject to considerable vibration under some conditions, especially since the adoption of steel for ship-building and high piston speed. To overcome it is daily becoming a matter of increasing importance, as higher and higher speeds are being continually demanded. It is to a study of the laws which govern this vibration, and to the possibility of avoiding it, that I invite your attention.

I will first describe some experiments which we have carried out during the last few years, with a view to throw light upon the subject. At the outset we felt the want of some means of accurately indicating and recording the extent and character of vibrations, and therefore devised an instrument for the purpose, which has been named a "vibrometer." This instrument is shown in the first engraving given. It has been in use for the last six years, and is, I believe, trustworthy. It consists, as will be seen, of a heavily weighted drum, suspended by elastic connections. This drum is provided with suitable clockwork to cause it to revolve, and is regulated to make one revolution per minute. Attached to an upright fixed to the stand of the machine is a pencil, which presses lightly against the drum, round which a sheet of paper is wrapped, in the same manner as in an ordinary indicator. It will be readily understood that if the base of this instrument be placed upon a platform or the deck of a vessel subject to vertical vibration, this movement will be transmitted to



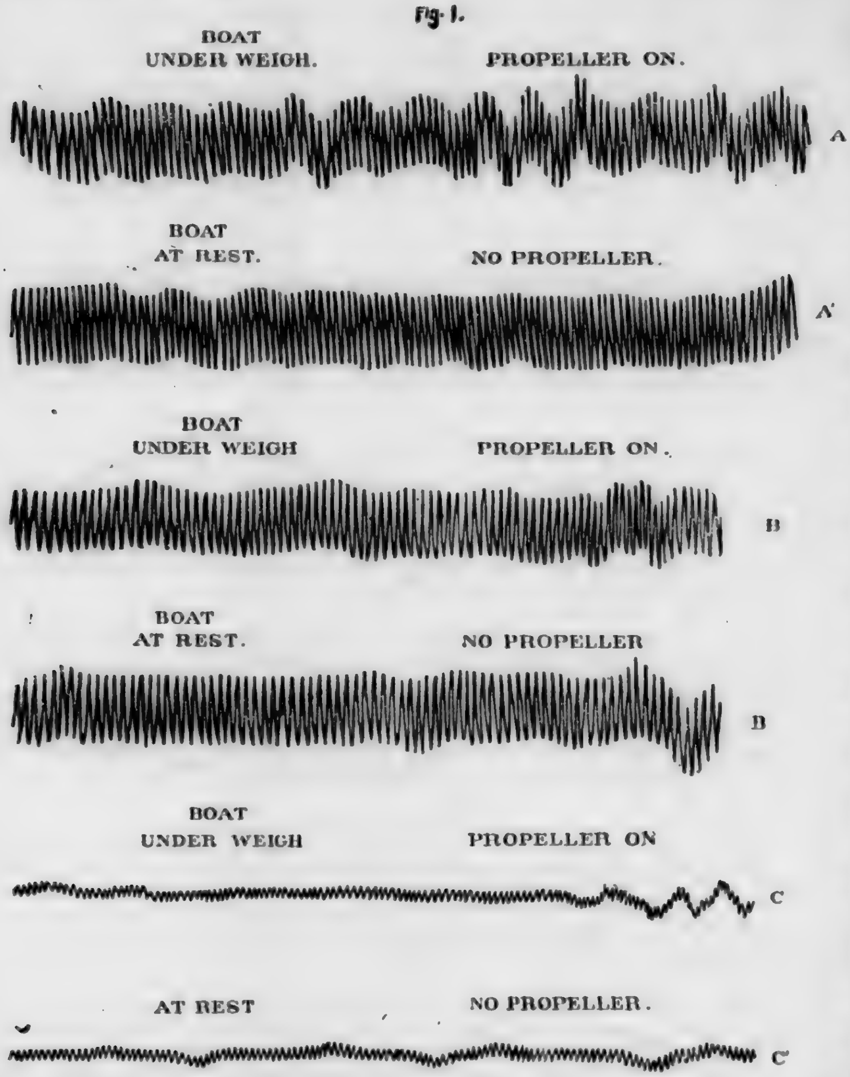
VIBROMETER

the whole apparatus, excepting that portion which is suspended by the elastic connection, and this, being heavily weighted, will not follow the vibratory motion of the stand. Now, if we place our instrument on the stern or any part of a steamer which is vibrating, and start the drum revolving, the pencil, being pressed against the paper, makes a line, indicating the relative vertical positions of the pencil and the paper, or, in other words, makes a diagram which records the character and extent of the movement of that part of the ship upon which the instrument stands.

I believe the cause of vibration in screw vessels, when running in smooth water with their propellers well immersed, to be mainly due to the forces produced by the unbalanced moving parts of the machinery, such as the pistons, piston-rods, valves, gear, etc., excepting when it is the result of bad workmanship or bad state of repair. For example, as clearly pointed out by Mr. Barnaby in his treatise on "Marine Propellers," vibration may be set up by a screw, the center of gravity of which is out of the center line of the shaft, or it may be due to want of uniformity in the position, area or shape of the blades. These causes being avoidable by proper care, I do not propose to deal with them. I would, however, take this opportunity to observe that sufficient attention is not always paid to these points.

From our experiments we have overwhelming proof that the vibration in a torpedo-boat is precisely the same in extent and character when the screw is on, and the vessel driven by it through the water, as it is when the boat is stationary and the engines simply revolving without doing work, the propeller being removed. To prove that this statement is correct, attention is called to fig. 1, upon which are shown enlarged vibrometer diagrams, which

Fig. 1.



have been obtained from torpedo-boats when running and when stationary. These diagrams represent a fair average of over a hundred results. It will be seen that diagrams A and A^1 are practically alike; also diagrams B and B^1, and diagrams C and C^1, A, B and C having been obtained when the boat was under weigh with propeller on, and A^1, B^1 and C^1, when the vessel was stationary, being without propeller. The engines were making exactly the same number of revolutions in each corresponding pair of diagrams. Not only do these diagrams prove that the screw had nothing to do with the vibration, and that it was owing to the working of the machinery, but it will be seen how greatly our investigation is facilitated by these facts, because experiments can be carried out with a boat at rest, and we know that the same results as regards vibration will be found under ordinary working conditions.

It is a well-known fact that engines will impart their vibration to a boat at certain speeds much more readily than at other speeds, and it often happens that at full speed a boat may be practically steady while at a slower speed the vibration is excessive. This is dependent upon the extent to which the movements of the reciprocating parts of the engine correspond with the period of vibration of the hull, which may be considered in this investigation as an elastic body. This is illustrated by the well-known fact that when soldiers are crossing a suspension bridge, it is often found necessary to avoid their marching in step. Some years since we had a boat in which severe vibration occurred at 200, 400, 600 and 800 revolutions per minute, but there was none at the intermediate speeds of 300, 500 and 700. The diagrams in fig. 2 show very clearly how the vibration varies at different speeds, and the variation that takes place in the extent of the vibration when passing from one speed to another.

In a vessel such as a fast Atlantic liner, which is intended to run continuously at a nearly uniform speed—unless special means be taken to balance the machinery—it is of the utmost importance to carefully avoid the number of revolutions of the engines per minute keeping time with, or, in other words, synchronizing with the normal vibration of the hull. This cannot be carried out in the case of war ships and others which are intended to run at varying speeds; for if the speed of the engines be proportioned so as not to set up vibration at full speed, they will probably do so at intermediate or cruising speeds, and if they set up no vibration at cruising speeds they will probably vibrate at full speed. I believe it would be by no means a difficult matter to determine in the original design, with fair accuracy, what speed of engine would be suitable to avoid vibration being set up in any given design of hull. We frequently hear of propellers being changed in order to reduce vibration, and in many cases the change is made with advantage; but it often happens that the improvement is not directly due to the altered shape of the propeller, but indirectly to the change causing an alteration in the number of revolutions of the engine, and thereby preventing them synchronizing with the natural vibration of the ship. We hear of hulls being strengthened or built stronger than would otherwise be necessary, with a view to reduce vibration. Doubtless this is done with more or less success; due possibly not so much to the greater strength of hull, but rather to the period of vibration being modified by this stiffening, so as to avoid its harmonizing with the movements of the machinery. Building vessels of greater strength than would otherwise be necessary, with the object of avoiding vibration, cannot be considered a scientific method of dealing with the difficulty, if it can be proved that vibration can be avoided by other means and without extra weight, because extra weight of material added to the ship tends to handicap its speed. The true cause of vibration being due to the machinery, I think it will be admitted that the correct mode of dealing with it is to so design the engines that they may be steady within themselves and free from any tendency to cause the hull to vibrate. As a further proof that the vibration is due to the machinery, I may mention that two years ago I made a passage to the United States in one of the very fast twin-screw steamers. I selected a berth in the central portion of the vessel, thinking it a good position for comfort, but the vibration was found to be so excessive that after five days it was scarcely bearable to those passengers whose berths, like my own, were situated at the points of greatest vibration. The vibration was found to vary periodically. When the two low-pressure pistons were descending at the same time it was excessive, but when one low-pressure piston was ascending and the other descending it was entirely neutralized. So distinct was the vibration in my cabin that it was quite easy to count the number of revolutions of the port and starboard engines, and we rigged up a temporary vibrometer on our cabin side, which gave us diagrams, indicating clearly the movements we were subject to. I believe all who have studied the subject of vibration in steamers will agree with me that many vessels which vibrate considerably are in consequence credited with weakness, while in reality they are of ample strength, the fault resting entirely with the engines and not with the hull. Not only is this vibration a source of discomfort to passengers, but it clearly adds considerably to the wear and tear of the vessel.

Let us consider exactly why an engine produces vibration. In an ordinary inverted engine the steam presses on the cylinder cover and on the piston, and from the piston the stress is transmitted to the bed-plate. Now, during

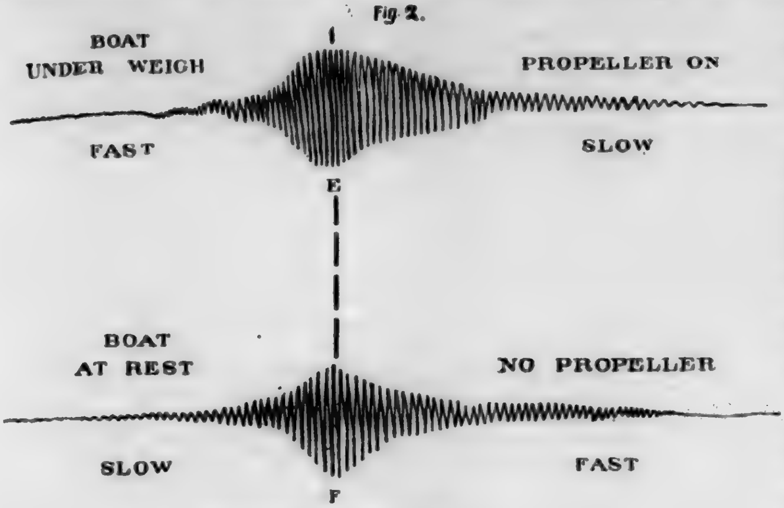
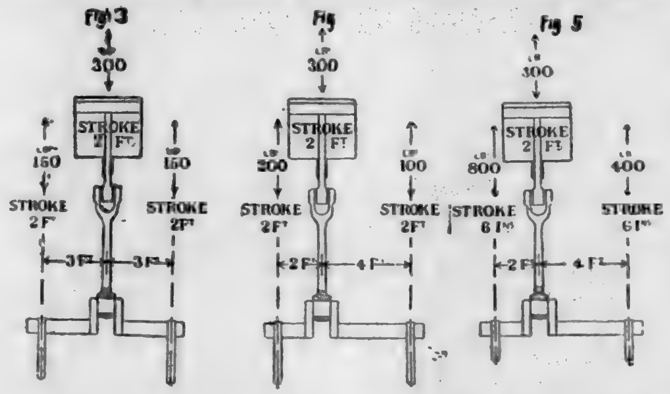


Fig. 2.

REVOLUTIONS AT EF
ABOUT 270 PER MIN

the first half of the down stroke the upward pressure on the cylinder cover is greater than the downward pressure on the bed-plate to the extent of what is needed to set the reciprocating parts in motion, and this excess of upward over downward pressure lifts the engine bed and that por-



tion of the hull to which it is attached. By a like train of reasoning it can be shown that during the latter half of the down stroke and the first half of the up stroke the tendency is to lower the engine bed; also that during the second half of the up stroke the tendency is to raise the

TRAVEL OF PISTONS = 16 ins
VALVES = 5 ins.

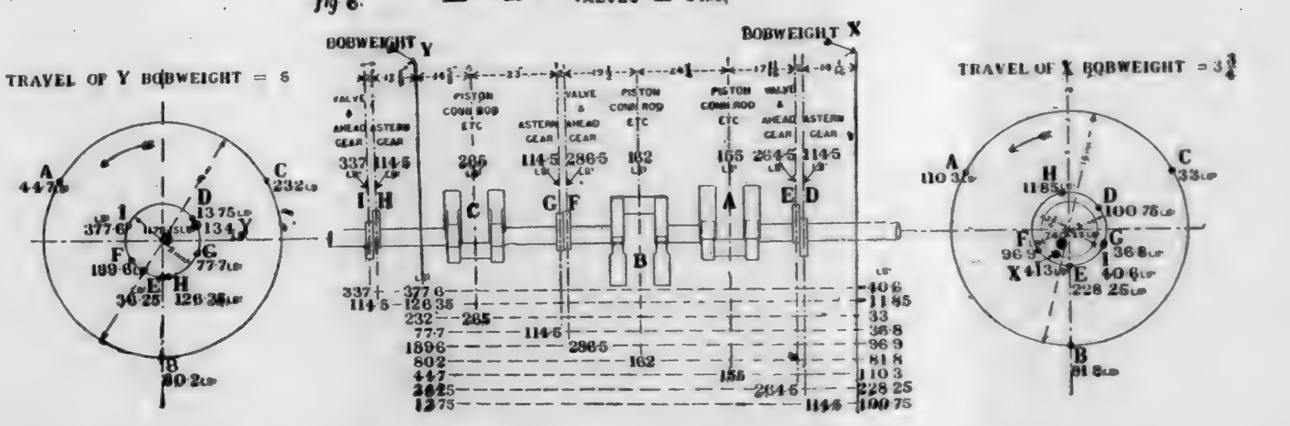


Fig 6.

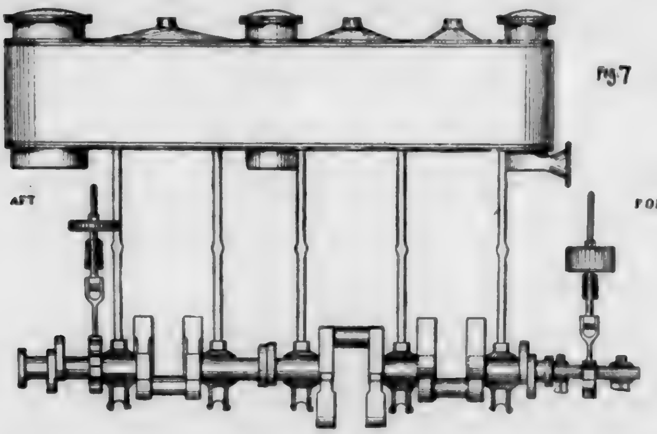
engine bed. To sum this up in a few words, during the upper half of the revolution the engine tends to lift the vessel, and during the lower half to depress it. The main principle which governs the whole matter may be thus summed up: As no internal force can move the center of gravity of a body, it follows that any momentum generated by steam pressure in the moving parts, such as the piston, etc., must be attended by an exactly equal momentum in the rest of the ship in the opposite direction.

We will now pass on to consider how to design engines so that they may be perfectly free from vibration. For this purpose reference is made to fig. 3, representing a single-cylinder inverted engine, which for the sake of simplicity we will assume has no valve gear. The revolving parts, such as the crank, crank-pin, and a portion of the connecting-rod, can be balanced by means of rotary weights in the usual way, and we then have only the vertical unbalanced parts, such as the piston, piston-rod, etc., left to deal with. Now, if we have two eccentrics set opposite to the crank, at equal distances from it, and of equal stroke to it, and these impart an up-and-down motion to weights, which we will call "bob weights," each of which is half as heavy as the parts to be balanced, that piece of mechanism will revolve free from vibration, excepting that which is due to the angle of the connecting-rods. If we wish to place these weights at unequal distances from the crank—see fig. 4—they must be proportioned to vary in weight inversely as their distances from the crank; that is, if one weight be twice as far from the center of the crank as the other, it will have to be half the weight of the other, the sum of the weights in this case being the same irrespective of their position. If we desire to reduce [illegible]troke of these weights so as to obtain a convenient le[illegible]f stroke—see fig. 5—we shall then have to increase their weight inversely as the stroke; that is, if we quarter the stroke the weight will have to be quadrupled, and so forth. It will thus be seen to be a simple matter to proportion the bob weights, their stroke, and their position, to suit what may best work in with any design of engine.

To sum up in a few words what must be done to avoid the effect of the momentum generated by the working parts being felt by the hull, an equal momentum in an opposite direction should be produced. If, instead of using bob weights, rotary weights of equal amount had been employed, having their centers of gravity in the same position as the centers of the eccentrics, which give motion to the bob weights, the engine would still be balanced vertically, but would be unbalanced horizontally.

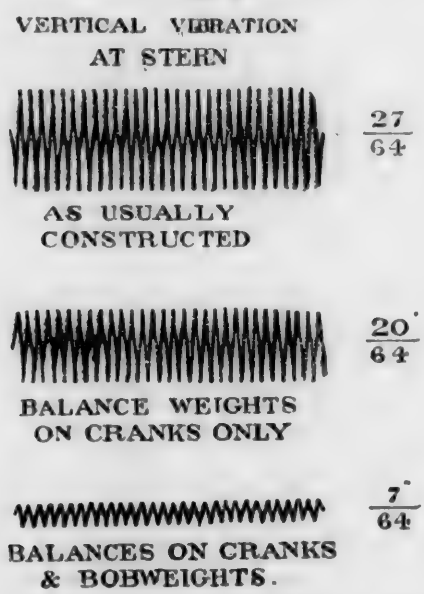
Attention is now called to fig. 6, showing the calculation as applied to triple-expansion vertical engines. The most suitable positions are first determined for fixing the two eccentrics which give motion to the bob-weights, in this case the one lettered X being at the forward end of the engines and the other lettered Y being between the low-pressure crank and its valve eccentrics. Each unbalanced moving part in the engine is then dealt with separately, as before described, and the position and amount of the weights necessary to balance it ascertained, the stroke of the balance weights being taken, for the purposes of calculation, as equal to the stroke of the part they balance in each case. For instance, take the middle-pressure piston, piston-rod, etc., lettered B, the unbalanced reciprocating parts of which weigh 162 lbs., the balance required at X is

found to be 81.8 lbs., and at *Y* 80.2 lbs., the stroke of each being 16 in. Taking another instance, for example, the high-pressure valve and its go-ahead gear, lettered *E*, weighing 264.5 lbs., the balance at *X* is found to be 228.25 lbs., and at *Y* 36.25 lbs., the stroke of each being 5 in. After dealing in a similar manner with all the reciprocating parts, if we were to construct two uniform disks with each of the weights thus found pinned on in its proper relative position, and place them respectively at *X* and *Y*, the engine would be balanced vertically. All the weights at *X* might be replaced by one large weight equal to the sum



of them, and having the same position of center of gravity; in a like manner the weights of *Y* may be dealt with. These are shown by the large black spots on the diagrams. These, again, might be substituted by larger or smaller weights as convenient, situated nearer or further from the center of the shaft, the amount of the weight being in the inverse ratio to the distance from the center. It will be seen

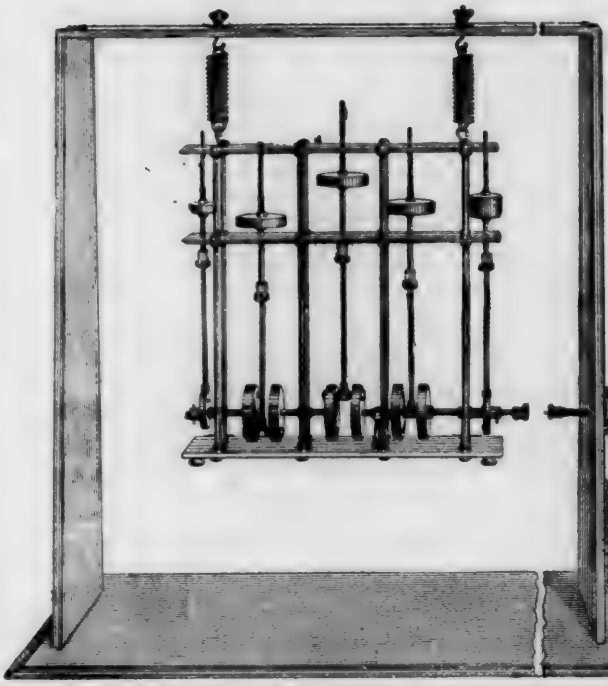
Fig. 8



that in the present case the total weight of all the balances equaled 740.25 lbs. at *X* and 1178.15 lbs. at *Y*, and the distance of their center of gravity from center of shaft was 1.04 in. and .28 in. respectively; these would be equivalent to a rotary weight of 413 lbs. at *X*, with its center of gravity 1⅞ in. from the center of the shaft, and a rotary weight of 134 lbs. at *Y*, with its center of gravity 2½ in. from the center of the shaft; these two weights would balance the engine vertically, but would set up side vibration. To avoid the latter and retain only the vertical effect, the use of bob weights equal to the rotary weights and having the same vertical motion, and in the same relative position on the shaft, are substituted. This method was adopted in the engines we shall refer to later on.

The correctness of this mode of calculation is confirmed by experience in practical working. The exact amount, position and stroke of the bob weights can be accurately calculated in the original design, and if they be made accordingly no vibrations will take place at any speed. The calculations are simple, but care must be taken that they are based on accurate data. To estimate the weights of the reciprocating parts from drawings is not sufficient; they should be ascertained by actually weighing the finished articles.

Triple-expansion engines with three cranks, although partially balanced when at rest, are very far from balanced when at work, owing to the distance between the various reciprocating parts, which consequently set up a rocking motion, which is the principal one to be overcome, and in such engines this rocking motion we have to deal with in addition to the vertical motion of the center of gravity, this vertical motion being due to the difference in weight of the working parts of the three engines. The positions of the bob weights should be chosen so as to minimize their weight. What weight may be necessary to avoid vertical vibration of the center of gravity is constant, but what may be required to avoid rocking motion is dimin-



MODEL ILLUSTRATING VIBRATION OF TRIPLE-EXPANSION ENGINES.

ished by an increased distance apart of the weights. In double-cylinder engines with the cranks at right angles it is a more pronounced galloping motion—that is, a motion of a complex kind, being a compound of vertical motions of their center of gravity and a rocking motion. In a single-cylinder engine the vibration of the engine is practically up and down; but with whatever type of motion we have to deal the same principle of balancing holds good. All forces causing vertical vibration can be neutralized by the use of bob weights, arranged to set up equal forces acting in an opposite direction. Some years ago we thought the vibration in triple-expansion engines was due to the difference in weight of the pistons, and with a view to balance them and, as we supposed, avoid vibration, we made each piston of the same weight in a first-class torpedo boat; thus we prevented any vertical movements of the center of gravity of the engines; yet we found no improvement. This clearly indicates that the rocking vibrations are of more importance than the vertical vibrations in triple-expansion engines.

There is one feature about the vibration of vessels which deserves attention, that it varies in intensity at different points in the length of the hull; there are places where it is excessive, and places termed nodes where it does not exist. Fig. 7 represents some engines indicating about 1,100 H.P. for a first-class torpedo boat, 130 ft. in length by 13 ft. 6 in. beam, having a speed of from 22 knots to 23 knots, carrying a load of 20 tons. There is nothing special about the engines excepting the two eccentrics fixed

on the shaft at each end, working vertical bob weights. To the cranks were fitted weights sufficient to balance them, the crank pins, and partially the connecting-rods. How far each connecting-rod was balanced by rotary weights was determined by its weight and the lateral movement of its center of gravity; what remained unbalanced was balanced by the bob weights worked by the eccentrics, their stroke and weight being calculated as already explained when describing fig. 6. Experiments were made with this boat in the Thames and also in the West India Dock. We tried her under three conditions—(1) without any balance weights whatever, as engines are usually constructed; (2) with balance weights on the cranks only; and (3) with balance weights on cranks and bob weights. The amount of vertical vibration at the stern as obtained in the river is given on fig. 8, together with enlarged vibrometer diagrams, from which it will be seen that the results corresponding to the three conditions show a vibration of $\frac{27}{64}$ in. as usually made, $\frac{20}{64}$ in. with balance weights on cranks, and $\frac{7}{64}$ in. with balances on cranks and bob weights. I have not the slightest doubt, from more recent experience, that this small vibration that remained could still further be reduced, and in fact practically avoided altogether, by taking greater care in accurately ascertaining the weight of all moving parts. The foregoing trials were all made at 248 revolutions per minute, which corresponded in this boat to the speed producing maximum vibration—that is to say, when the movement of the engine synchronized to the greatest extent with that of the boat. I believe that the vibration of the largest Atlantic liner can in this way be practically overcome by the expenditure of a few hundred pounds, if carried out in the original design. Bob weights proportioned and arranged as already described may be reduced in amount if wished, being substituted by a rotary balance weight equal to such reduction; this, however, must not be carried out to an extent to produce sensible side vibration.

Some instantaneous photographs taken during these trials showed in a very interesting way the degree of vibration by the peculiar ripples produced on the surface of the water.

To further illustrate the system and prove its correctness, I had made a model corresponding to a triple-expansion engine; the weights of the pistons have been similarly proportioned to one another, as in our torpedo boat engines. The shaft is made to revolve by a flexible wire, so as to avoid the result being vitiated by the mode adopted for causing it to revolve. This model engine is suspended by springs in order to be quite free to move vertically, as shown in the last engraving given.

When this model engine is put in motion unmistakable vibration is at once set up. The rotary weights, such as crank, crank-pin and lower ends of connecting-rods, are all carefully balanced by balanced disks, and consequently this vibration is due entirely to the vertical moving parts. When we connect on each side the bob weights the amount, stroke and position of which have been arrived at by a similar calculation to that already described, the effect of these bob weights in completely avoiding the vibration becomes very clearly apparent, thus serving as further proof of the facts shown by the previous experiments.

MASTER MECHANICS' ASSOCIATION REPORTS.

A NUMBER of reports were submitted to the Master Mechanics' Association at the Saratoga Convention. The longest report and the one which attracted most attention was that upon Compound Locomotives, which has been referred to separately. The report on Uniform Locomotive Performance Sheets is given in full on another page. Of the others we present a brief summary below.

BOILERS FOR HIGH-PRESSURE LOCOMOTIVES.

This Committee states that there is some difference of opinion as to what is high pressure in a locomotive boiler. Not long since 150 lbs. was considered high, but this has now become common and the Committee has therefore decided to call anything in excess of that high pressure. As a matter of fact 160 lbs. is not uncommon, and 180 lbs. is frequently used with compound engines, while 190 and 200 lbs. are advocated. A number of designs for boilers have been submitted to the Committee and transmitted by them to the Association. The Belpaire type of boiler seems to be meeting with considerable favor, and the substitution in other types of boiler of radial stays for crown-bars on the fire-box is also increasing. In all types of boiler the greatest trouble seems to be given by broken stay-bolts near the top of the fire-box, but it is believed that this can be to some extent avoided by increasing the length of the stay-bolts, reducing the width of the fire-box at the top. This would somewhat diminish the heating surface, but this would be offset by the increasing life of the stay-bolts and the freer steam. The Committee believe that the reduction of transverse strains in the stay-bolts obtained by increasing their length is much greater than is generally supposed. Good practice also requires that the water-spaces should be made as wide as possible, and that the mud-ring should be increased in size and double riveted. It is also important that there should be as few joints as possible, that the sheets should be made as large as the design of the boiler will permit, and that the waist or cylinder part of the boiler should always be in one sheet. The Committee considered that the radial-stayed and Belpaire types will meet with general acceptance, and that they are at present to be considered as the best forms of boiler for locomotive purposes.

AIR-BRAKE AND SIGNAL INSTRUCTIONS.

The Committee on this subject presented a code of air-brake and signal instructions, which was adopted jointly with the Committee of the Master Car-Builders' Association on the same subject. This code will be published in pamphlet form, and will be adopted as the standard of the Association.

TESTS OF STEEL AND IRON.

The Committee on this subject made a number of experiments intended to decide whether it is true that at a blue heat—about 600°—steel is extremely liable to crack in bending. Other experiments were also made to ascertain the relative value of steel and iron tubes, to determine the temperature of fire-box sheets and the effect of vibration upon stay-bolts.

The results of the investigations so far may be summarized as follows:

1. Steel or iron should not be worked at a temperature between a normal temperature and a perceptible red heat.

2. So-called "blue heat" makes steels and irons more brittle, but some are apparently less affected by the blue heat than others.

3. The test of steel or iron at a blue heat is not a criterion by which to judge of the action of the same in a fire-box.

4. Iron at a blue heat is more seriously affected than steel.

5. There is apparently a mechanical disintegration going on in plates exposed to the action of fire, water and scale in a fire-box.

6. Steel tubes do not seem to be as durable as iron tubes.

The Committee do not consider that their investigations are conclusive, and ask that they be continued; which was approved by the Convention.

STANDARD BOLTS AND NUTS.

This Committee gives a brief historical account of the adoption of the Sellers or United States standard for screw threads, and describes the gauges used for threads and for taps and dies, which are now considered the standards of the Association. Some excellent recommendations as to practice in fitting up bolts are also made. In conclusion the Committee makes the following recommendations:

1. That the Association commend and emphasize the United States standard, and urge a rigid adherence to the same, and deprecate the use of over or under-sized bolts and nuts.

COMPOUND LOCOMOTIVES AT THE SARATOGA CONVENTION.

2. It is practicable to maintain the standard with the methods and gauges available.

3. It recommends the adoption by the Association of the United States standard for size of nuts, based upon rough size, regardless of finished nuts.

These recommendations were approved, and the Committee was instructed to prepare a circular calling attention to their importance.

AN EXHIBIT OF COMPOUND LOCOMOTIVES.

THE engraving given herewith is from a photograph of the exhibit made by the Schenectady Locomotive Works at the Master Mechanics' Convention at Saratoga. It included three engines of the two-cylinder compound type which the Schenectady Company has advocated and adopted, and of which it has already built quite a number.

The first of these engines and the one, from its position, shown most prominently in the engraving was a ten-wheel passenger engine built for the new Adirondack & St. Lawrence Railroad. This engine is built for fast passenger service on a line with heavy grades, and is a powerful machine. The high-pressure cylinder is 20 in. and the low-pressure 30 in. in diameter, both being 26 in. stroke. The driving-wheels are 70 in. in diameter. The forward drivers have plain tires; the total wheel-base is 23 ft. 3 in., the driving-wheel-base 12 ft. 6 in. and the rigid wheel-base 6 ft. 5 in. The total weight of the engine is 141,000 lbs., of which 108,000 lbs. are carried on the drivers and 33,000 lbs. on the truck. The tender is of the usual pattern, and the tank will hold 4,000 gallons of water.

The second engine in the row is a twelve-wheeled freight engine for the Southern Pacific Company, having eight coupled drivers and a four-wheeled truck. This engine has a high-pressure cylinder 20 in. and low-pressure 29 in., and 26 in. stroke. The proportion of the cylinders is 1 : 2.10, or slightly different from the engine first described, where the proportion is 1 : 2.25. The driving-wheels are 51 in. in diameter. The total wheel-base is 23 ft. 7 in.; the driving-wheel-base, 13 ft. 9 in., and the rigid wheel-base 9 ft. 2 in. The total weight of this engine is 138,800 lbs., of which 20,000 lbs. are carried on the truck and 116,800 lbs. on the drivers. The tender will carry 4,000 gallons of water.

The third engine, which is not very clearly visible, owing to its position in the line and the angle at which the photograph was taken, is a Mogul freight engine, with six drivers and a two-wheeled truck. This engine has cylinders 20 in. and 30 in. in diameter and 26 in. stroke; the driving-wheels are 57 in. in diameter. The total wheel-base is 21 ft. 11 in.; the driving wheel-base is 14 ft. The total weight is 132,500 lbs., of which 114,500 lbs. are on the drivers and 18,000 lbs. on the truck. An engine of this type recently did some remarkable work on the New York Central road, where it was run for a few trial trips.

PROGRESS IN FLYING MACHINES.

By O. CHANUTE, C.E.

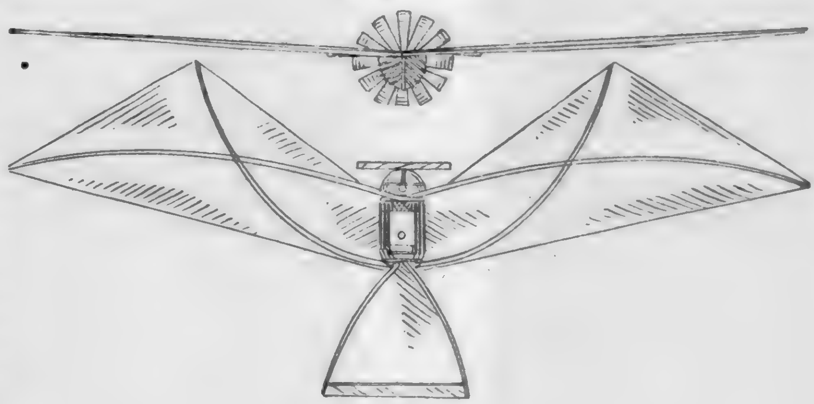
(*Continued from page* 308.)

THE next apparatus to be noticed was thoroughly experimented with, and years were spent in the endeavor to put it into practical operation. It was first patented by M. *Felix du Temple*, a French naval officer, in 1857, and is shown in fig. 41; the top figure representing an end view from the rear and the lower figure being a top view. It consisted in two fixed wings of silk fabric, stretched by curved spars of wood or metal, and firmly attached to a car containing the motor. In front of this a screw was attached with a pivoted axle, in order to draw the apparatus forward. An horizontal tail hinged at the car was to regulate the angle of incidence and of flight of the machine, while a vertical rudder under the tail and separate from it was to steer to the right or left.

The car was to be shaped like a boat, lightly constructed of wood or iron ribs, and might be covered on the outside with tarred or rubber cloth. Beneath it were to be hinged three hollow legs, which might either be folded up or allowed to hang down. Strong springs inside of them were to carry rods or feet, at the outer end of which were to be wheels to roll over the ground. These legs were to be so adjusted in length that the apparatus should present an angle of incidence of about 20° to the horizon, and upon being put into forward motion, at the rate of about 20 miles per hour by the screw, it was expected to rise upon the air and to enter upon its flight, the latter being regulated by the horizontal tails and by the vertical rudder.

The motor might be steam, electricity, or some other prime mover, and it was estimated that 6 H.P. would be required for an apparatus; weighing one ton. This was a very great underestimate, for the proposed plan of driving the machine over the ground by means of the aerial screw would largely increase the resistance, and sufficient speed could not be obtained to rise upon the air.

REAR VIEW.



PLAN.

FIG. 41.—DU TEMPLE—1857-1877.

M. *Du Temple* tried many experiments with models shaped like birds, and his patent indicates that he had carefully considered the question of stability, for he places the preponderance of weight toward the front of the car, provides for a diedral angle during flight by the flexibility and shape of the wings, and produces a slight turning up of the rear edge by making it flexible, all much as in the paper aeroplane which has been described. There was a weak point, however, in the fact that the center of gravity was not adjustable during flight, so as to correspond with the change in the center of pressure, produced by such alterations in the angle of incidence as might result from the action of the tail or otherwise.

When he began with the aid of his brother, M. *Louis du Temple*, to experiment on a large scale, the inadequacy of all motors then known became apparent. They first tried steam at very high pressures, then a hot-air engine, and finally built and patented, in 1876, a very light steam boiler weighing from 39 to 44 lbs. to the horse power, which appears to have been the prototype of some of the light boilers which have since been constructed. It consisted in a series of very thin tubes less than $\frac{1}{8}$ in. in internal diameter, through which water circulated very rapidly, and was flashed into steam by the surrounding flame.

This is understood to have been applied to a slightly modified form of the main apparatus, built in 1874 at Brest by M. *Du Temple*. This was calculated to carry a man, was 40 ft. across from tip to tip, weighed about 160 lbs., and cost upward of $6,000, the workmanship being very fine.

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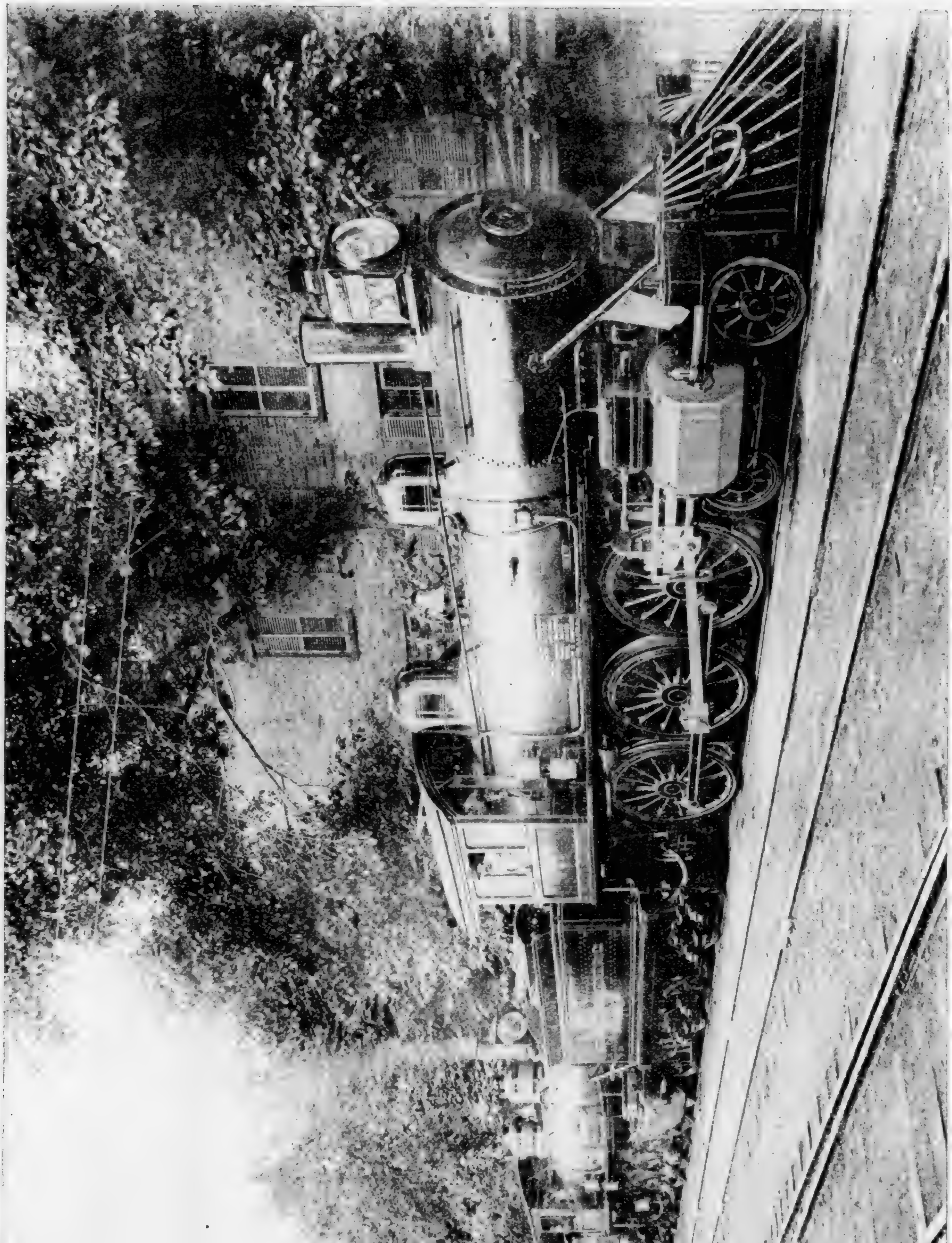

COMPOUND LOCOMOTIVES AT THE SARATOGA CONVENTION

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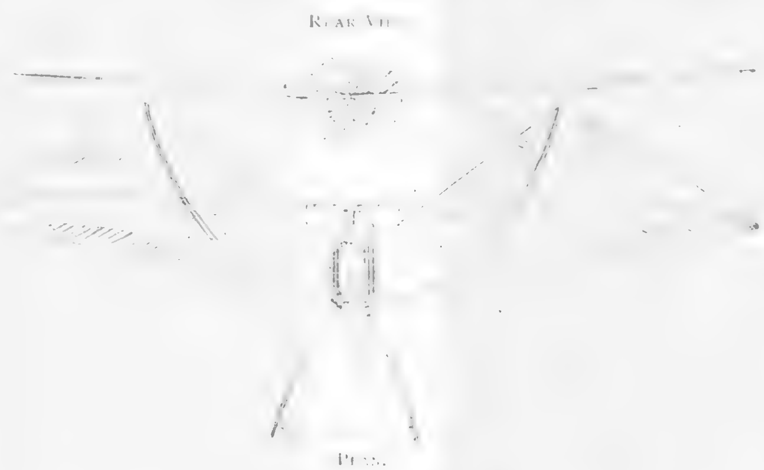

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Careful search by the writer through various French and English publications has failed to discover any ac-

count of the operation of this machine, save the statement of M. *Tissandier* that "notwithstanding most persevering efforts, no practical results could be obtained in experimenting with this apparatus."

In 1858 *Jullien*, a French clock repairer of Villejuif, who had already exhibited in 1850 the first model of a fish-shaped navigable balloon which operated with its own motor, propeller, and steering gear, endeavored to prove what could be accomplished with aeroplanes. He exhibited to the French Society of Encouragement for Aviation a model weighing only 1¼ oz., although its aeroplane measured 39 in. across the line of motion. It was propelled by two screws each with two arms, and the power was furnished by the tension of a rubber band wound over two conical spools of equal diameter, like the *fusée* of a watch, in order to maintain the force uniform. The angle of incidence was about 10°, and the apparatus proceeded horizontally in a straight line a distance of 40 ft. in five seconds, with an expenditure of 0.52 foot-pounds per second.

Jullien proposed to build a large apparatus upon the same principle, but he failed to obtain the requisite financial backing. He saw, clearly enough, that he must have a light motor, and he began to experiment with electricity, seeking chiefly a light primary battery. In 1866 he announced that he had succeeded in devising an electric motor and battery weighing at the rate of 82 lbs. per H. P. with which he expected to drive an aeroplane through the air during an entire day; but he did not receive the encouragement or aid of capital, and this ingenious inventor, who had struggled all his life long with inadequate means, died miserably poor, in a hospital in 1877.

The singular machine patented in 1860 by Mr. *Smythies*, while quite impracticable in form, is here mentioned in order to make known two novel proposals—*i.e.*, the utilization of the aeroplanes as steam condensers and the proposed means for shifting the center of gravity while in flight. A top view is shown by fig. 42. The apparatus was to

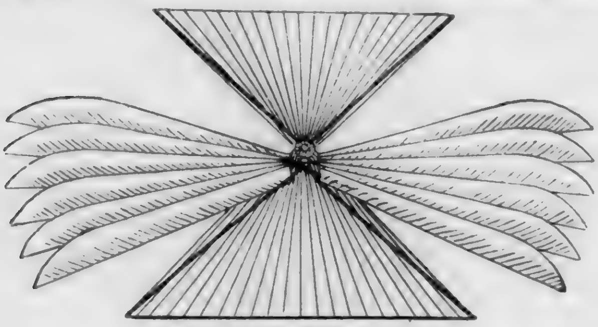


FIG. 42.—SMYTHIES—1860.

consist of extended plane surfaces in order to furnish the support, and to be propelled by the alternating motion of wings actuated by a boiler and engine of a peculiar kind.

The boiler was to be upright, its top view being indicated by the circles at the junction of the two planes. It was to be fitted with small vertical water-tubes, thickly placed in a "flame-chamber" heated by the combustion of some volatile fluid mixed with air. Back of the boiler an upright cylinder was to be placed to work the wings up and down, feathering motion being imparted to the vanes composing them (by compound levers), so that they should separate slightly on the up-stroke and firmly close on the overlap on the down-stroke.

The whole of the two aeroplanes and of the upright boiler was to be encased in a closed flat bag of oiled silk or other light air-tight covering—that is to say, that a steam surface condenser was to be provided by making a hood, tapering on its top and bottom from the thin edges at the front and rear of the apparatus to a thickness at the center equal to the height of the boiler. This hood or case was to be kept distended by spars and by light cords, and the spent steam was to be exhausted therein so as to be condensed by contact with the sides, and the water thus produced was to drain into a reservoir at the bottom, whence it was to be pumped back into the boiler, thus keeping the total weight of the apparatus constant and utilizing the same water over and over again.

The operator was to be suspended in an adjustable seat beneath the center of gravity of the machine, and by shifting his position sideways or fore and aft, was to guide the machine to the right or left, or up and down through the changes thus produced in the position of the center of gravity and consequent angle of incidence. Elastic legs beneath the whole were to break the fall on alighting; the descent being, moreover, retarded by the action of the wings, in which both the amplitude of movement and the overlap of the vanes or "feathers" were under the control of the operator through a series of cords.

This apparatus as designed was quite impracticable, but it indicates that the inventor had been watching the birds and had become aware of some requirements overlooked by his predecessors, such as the necessity for adjusting during flight the center of gravity to coincide with the center of pressure consequent upon changes in the angle of incidence, in order that the equilibrium may be preserved; the necessity for more energetic efforts and greater angles of incidence at starting and in alighting than during horizontal flight, and also the necessity for an air condenser to liquefy the steam, if the latter is to be used as a motive power, both to diminish the weight of the water required and to keep the weight constant.

(TO BE CONCLUDED.)

LEGISLATION ON SAFETY APPLIANCES.

THE Committee on Interstate Commerce of the House of Representatives has presented a report on the various bills submitted to it relating to the adoption of safety appliances on the railroads subject to the Interstate Commerce Law. The report discusses the demand submitted for protection by railroad employés, the nature of accidents as indicated by the report of the Interstate Commerce Commission, and the apparent inability of the railroads to agree upon the proper remedy, and ends by submitting to the House a bill intended to take the place of the various measures which were before the Committee. From its importance it has been considered best to give the text of this bill in full.

A BILL to promote the safety of employés and travelers upon railroads by compelling common carriers engaged in interstate commerce to equip their cars with automatic couplers and continuous brakes and their locomotives with driving-wheel brakes, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that on and after the first day of July, 1893, it shall be unlawful for any common carrier engaged in interstate commerce by railroad to put into use on its line any new locomotive to be used in moving interstate traffic that is not equipped with power driving-wheel brakes.

SEC. 2. That from and after the first day of July, 1895, it shall be unlawful for any such common carrier to use on its line any locomotive engine in moving interstate traffic that is not equipped with a power driving-wheel brake so arranged as to be operated in connection with the train-brake system.

SEC. 3. That on and after the first day of July, 1895, it shall be unlawful for any such common carrier to use on its line for the purpose of moving interstate traffic any new car or any old car that has been to the shops for general repairs to one or both of its draw-bars that is not equipped with automatic couplers of the standard designated under and in accordance with the provisions of this act.

SEC. 4. That on and after the first day of July, 1898, it shall be unlawful for any such common carrier to haul or permit to be hauled or used on its line any car used in moving interstate traffic unless such car is equipped with automatic couplers of the standard designated under and in accordance with the provisions of this act.

SEC. 5. That on and after the first day of July, 1895, no such common carrier shall put into use or haul or permit to be hauled on its line for the transportation of interstate freight traffic any new car belonging or leased to it or any old car belonging or leased to it which subsequently to the passage of this act has been sent to its shops for general repairs, unless such car is equipped with brakes for each wheel and with train-brake apparatus of such a nature that the brakes can be set and released from the locomotive.

SEC. 6. That on and after the first day of July, 1898, no such common carrier shall haul or permit to be hauled on its line for the transportation of interstate freight traffic any car which is not equipped with brakes for each wheel and with a train-brake apparatus of such a nature that the brakes can be set and released from the locomotive.

SEC. 7. That on or before the first day of July, 1893, every such common carrier shall file with the Interstate Commerce Commission in Washington a statement certified to under oath by the president and clerk of the corporation, as the action of said corporation through its board of directors, setting forth such details with reference to the height, form, size, and mechanism of freight car couplers as it deems essential in order to insure requisite uniformity, requisite automatic action, and requisite safety in service, and also stating the number of freight cars owned by it and under its control, and also the number of other cars under its control by lease on the thirtieth of June, 1892, exclusive of those used solely for state traffic. Such statements shall be made upon blanks to be provided by the Interstate Commerce Commission, and the determination of such commission in relation to the validity of the several statements received shall be final. If upon examining the statements so received said Interstate Commerce Commission is of opinion that companies owning at least 75 per centum of the freight cars owned and controlled as aforesaid by companies which shall have duly filed statements as aforesaid have agreed upon such details of freight-car couplers as will insure requisite uniformity, requisite automatic action, and requisite safety in service, said Commission shall thereupon declare and publish that couplers complying with such details so agreed upon shall thereafter, until otherwise ordered according to law, be the standard couplers for use in the freight-car interstate service. If the common carriers shall fail to establish a standard coupler as herein provided, then the standard automatic coupler shall be such coupler as shall be selected by the Interstate Commerce Commission; and it is hereby made the duty of said Commission, within six months after the first day of July, 1893, to select and designate some automatic coupler as a "standard type," under the provisions of this act, and to promulgate notice of such selection.

SEC. 8. That after July 1st, 1898, any such common carrier may refuse to accept or receive any car used in interstate commerce that is not properly equipped as required by this act, and the carrier loading or starting such car shall be liable for the damages if any result therefrom.

SEC. 9. That from and after the first of July, 1893, until otherwise ordered by the Interstate Commerce Commission, it shall be unlawful for any railroad company to use any car in interstate commerce that is not provided with secure handholds in the ends and sides of each car.

SEC. 10. That within 90 days from the passage of this act the American Railway Association is authorized hereby to designate to the Interstate Commerce Commission the standard height of draw-bars for freight cars, measured perpendicular from the level of the tops of the rails to the centers of the draw-bars, and shall fix a maximum variation to be allowed between the draw-bars of empty and loaded cars. Upon their determination being certified to the Interstate Commerce Commission, the Commission shall give notice of the standard fixed upon, at once, to all common carriers, owners, or lessees engaged in interstate commerce in the United States by such means as the commission may deem proper, and thereafter all cars built or repaired shall be of that standard. But should said Association fail to determine a standard as above provided, it shall be the duty of the Interstate Commerce Commission to do so. And after July 1st, 1893, no cars shall be used in the interstate traffic which do not comply with the standard above provided for, either loaded or unloaded.

SEC. 11. That an employé of any such common carrier who may be injured by any locomotive, car, or train in use contrary to the provisions of this act shall not be deemed guilty of contributory negligence, although continuing in the employ of such carrier after habitual unlawful use of such locomotive, car, or train had been brought to his knowledge.

SEC. 12. That any such common carrier violating any of the provisions of this act shall be liable to a penalty of $100 for each and every such violation, to be recovered in a suit or suits to be brought in the district court of the United States having jurisdiction in the locality where such violation shall have been committed by the United States district attorney of such district, and it shall be the duty of such district attorney to bring such suits upon duly verified information being lodged with him of such violation having occurred. And it shall also be the duty of the Interstate Commerce Commission to lodge with the proper district attorneys information of any such violations as may come to its knowledge.

This bill is now on the calendar of the House, but the condition of business is such that it will hardly be acted on at the present session, and will probably go over to next winter's session.

ACCIDENTS AND LONG HOURS OF WORK.

AN investigation into the hours of labor required from railroad employés in England is now in progress; and a recent number of the London *Times* reports some interesting testimony given before the Parliamentary Committee by Major Marindin, who has been for a number of years Inspector of Railroads for the Board of Trade. In this connection it might be suggested that there are cases in this country where an investigation might show some connection between accidents and the fatigue due to long hours of work. The substance of Major Marindin's testimony is given below:

Major Marindin stated that it was part of his duties to inquire into and report upon train accidents. Since the date of his appointment he had held 429 inquiries himself, and during the years 1888, 1889, 1890 and 1891 there were held by the three inspecting officers 257 inquiries. During the last four years he had had on 23 occasions to call attention to the fact that the hours of work of some of the men were excessive. In addition to the accidents which he himself had called attention to, other inspecting officers had called attention on 24 occasions to the long hours of work, and upon 11 occasions they had reported that the servant held responsible for the accident, or partially so, had worked very long hours; upon nine occasions the accident had been attributed to some extent to these long hours of work. On the last occasion, when he investigated an accident on the Lancashire & Yorkshire Railroad, he drew attention to the fact that one of the men engaged at the time had been on duty fifteen hours. With regard to the necessity or practicability of legislation with reference to the hours of work of railroad servants, although he was very strongly of opinion that very long hours were an evil and must be put an end to somehow, he did not think that at present it was desirable to put any statutory limitation to their hours. He would rather leave the matter to the force of public opinion, which certainly did have a great effect on the companies. No Board of Directors could afford to disregard the strong opinion that had been expressed as to the evil of long hours, especially if the Committee were to report in the same sense. The railroad companies in the past had not done what they might have done to keep the hours of work within a reasonable limit, but of late there had been an improvement, as was shown by the returns which had been put in by the Secretary of the Railroad Department of the Board of Trade. Railroad managers would, he hoped, in future recognize the bad economy of overworking their servants. He thought the moral effect of a censure from the Board of Trade would be considerable, although the Board was allowed no legal power in the matter. Owing to the enormous variety of circumstances under which railroad servants worked, it would be almost impossible to lay down any hard-and-fast rule as to the hours of work. For instance, ten hours a day would be quite enough for an express driver, but he could easily conceive a case on a branch line with a shuttle traffic, where a driver doing thirteen hours, owing to frequent intervals of rest, would have a comparatively easy time compared with the man who was constantly driving for eight or nine hours. In the case of signal-men it was almost impossible to fix whether a signal-box should be an eight, ten, or twelve hours' box, except by considering each case on its merits. In a box of the Underground Railroad, for instance, there were really only six or eight levers, but the number of trains passing was so great that the signal-man had never any rest at all, and the strain upon him was immeasurably greater than it was upon a man in a box on another line containing, perhaps, five times that number of levers. He did not think signal-men should work more than eight or ten hours. It was not a common thing for these men to work over twelve hours; but sometimes men for their own convenience, when in twelve-hour

LOCOMOTIVE RETURNS FOR THE MONTH OF APRIL, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.
Alabama Great Southern	....	56	53,688	79 912	39,501	173,101	3,031	....	....
Alabama & Vicksburg	....	15	17,565	14,911	11,136	43,612	2,907	....	....
Atchison, Topeka & Santa Fé	834	724	....	... .. .	317,832	2,075,424	2,867	....	....
Canadian Pacific	593	...	480,127	786,365	310,790	1,577,282	2,655	. ..	....
Chic., Burlington & Quincy	505	...	....	....	....	1,652,702	3,253	4.90	17.72
Chic., Milwaukee & St. Paul	804	....	....	. .....	.. ... .	2,350,845	2,024	....	....
Chicago & Northwestern	856	....	658,324	1,259,072	657,205	2,574,601	3,008	....	....
Cincinnati Southern	....	100	77,669	160,074	75,761	313,504	3,135	. ..	.. .
Cleve., Cinn., Chic. & St. L.	....	428	403,651	565,158	339,771	1,308,580	3,058	4.30	21.0
Cumberland & Penn.	22	22	4,970	28,242	....	33,212	1,510	....	....
D., L. & W., Morris & Essex Div.	156	...	162,416	254,010	12,673	426,099	2,732	....	....
Hannibal & St. Joseph	41	37	44,484	74,121	20,278	141,883	3,835	4.89	15.67
Kan. City, F. S. & Mem.	150	....	98,652	222,970	107,620	492,242	2,861	....	....
Kan. City, Mem. & Birm.	41	39	47,078	49,607	17,078	93,763	2,404	...	....
Kan. City, St. Jo. & Council Bluffs	44	42	60,515	39,066	38,033	137,614	3,276	4.74	20.02
Lake Shore & Mich. South	587	....	415,863	766,501	573,095	1,755,459	2,991	....	....
Louisville & Nashville	....	*342	420,140	766,833	373,909	1,560,882	3,471	4.96	15.87
Manhattan Elevated	....	291	765,913	....	64,845	830,758	2,855	..	....
Mexican Central†	146	118	....	.... . .	....	362,194	3,069	....	.. .
Mil., L. S. & West	112	104	75,981	157 257	86,098	319,336	3,071	....	....
Minn., St. P. & Sault Ste. Marie	....	....	62,257	137,182	33,825	233,264	.....	4.87	17.24
Missouri Pacific	339	304	....	....	....	1,036,496	3,406	4.30	16.16
N. O. & Northeastern	.. .	27	26,303	37,991	21,335	86,229	3,194	....	....
N. Y., Lake Erie & West	622	....	431,289	957,827	275,590	1,664,706	2,676	4.60	22.20
N. Y., Pennsylvania & Ohio	263	....	138,404	441,891	134,631	714,926	2,718	5.30	18.20
N. Y., Prov. & Boston	....	89	105,509	47,912	58,170	211,600	2,378	....	...
Norfolk & Western, Gen. Eastern Div.‡	....	131	97,320	232,670	70,625	400,616	3,057	4.40	19 80
Durham Division‡	....	6	7,182	9,934	4,343	21,459	3,577	4.90	4.70
Radford Division‡	....	50	16,326	111,902	9,292	137,520	2,750	5.20	17.90
Pulaski Division‡	....	28	26,447	46,243	8,221	80,911	2,890	4.90	17.70
Clinch Valley Division‡	....	40	20,341	52,448	17,423	90,212	2,255	3.80	10.70
Ohio & Mississippi	112	....	131,647	146,800	87,703	366,152	3,269	..	....
Old Colony	....	213	307,961	126,411	118,877	553,249	2,597	....	.. .
Philadelphia & Reading	....	....	440,840	388,852	515,582	1,645,274	....	....	....
South. Pacific, Pacific Sys.	701	....	....	.... ..	.. ....	1,571,383	2,242	....	....
Union Pacific	992	...	709,971	1,162,322	486,802	2,359,102	2,378	5.55	16.13
Vicksburg, S. & P.	....	14	11,568	8,816	9,902	30,286	2,163	....	....
Wabash	401	337	395,035	620,511	226,698	1,242,244	3,686	4.95	17.30
Wisconsin Central	152	143	124,889	223,486	66,084	415,359	2,005	...	....

Name of Road.	Coal Burned per Mile. Passenger Train Mile. (Lbs.)	Freight Train Mile. (Lbs.)	Service and Switching Mile. (Lbs.)	Train Mile, all Service. (Lbs.)	Passenger Car Mile. (Lbs.)	Freight Car Mile. (Lbs.)	Cost per Locomotive Mile. Repairs. (Cts.)	Fuel. (Cts.)	Oil, Tallow and Waste. (Cts.)	Other Accounts. (Cts.)	Engineers and Firemen. (Cts.)	Wiping, etc. (Cts.)	Total. (Cts.)	Cost per Car Mile. Passenger. (Cts.)	Freight. (Cts.)	Cost of Coal per Ton. ($)
Alabama Great Southern	58.48	92.59	37.37	69.93	...	...	5.60	4.70	0.24	0.40	6.30	1.80	19.14	...	...	....
Alabama & Vicksburg	52.08	103.63	57.31	71.17	....	....	5.60	6.40	0.33	0 60	6.10	1.80	20.63	....	....	....
Atchison, Topeka & Santa Fé	...	....	....	82.29	....	....	4.77	6.64	0.28	0.13	6.52	1.36	19.70	....	. ..	1.52
Canadian Pacific	....	....	...	67.02	....	...	3.95	11.90	0.43	....	5.37	1.05	23.05	....	1.97	3.49
Chic., Burlington & Quincy	....	....	....	[illegible]	....	....	4.92	5.80	0.21	0.32	6.97	...	18.22	....	...	1.36
Chic., Milwaukee & St. Paul	....	....	....	73.34	....	.	5.16	7.55	0.28	...	7.00	....	19.99	....	....	2.00
Chicago & Northwestern	....	....	....	86.02	....	. ..	3.62	7.90	0.36	....	6.30	0.88	19.06	....	....	1.81
Cincinnati Southern	61.54	125 00	34.96	89.19	....	....	3.70	6.00	0.28	0.50	6.40	1.70	18.58	....	....	...
Cleve., Cinn., Chic. & St. L.	73.67	114.02	70.82	90.33	17.13	5.43	3.36	5.80	0.18	1.95	6.36	0.25	17.90	.. .	....	1.28
Cumberland & Penn.	....	....	....	84.74	.. .	...	6.14	4.80	0.40	...	....	1.80	13.14	....	....	....
D., L. & W., Morris & Essex Div.	..	....	....	62.73	....	....	4.11	9.78	0.35	....	6.16	....	20.40	....	. ..	3 08
Hannibal & St. Joseph	....	...	....	82.64	14.66	6.53	3.97	5.17	0.15	0.26	6.59	...	16.14	....	....	1.32
Kan. City, F. S. & Mem.	.. .	....	....	61.71	....	...	4.21	5.45	0.16	0.55	7.44	....	17.61	....	....	1.71
Kan. City, Mem. & Birm.	...	....	....	54.39	....	....	2.65	3.29	0.26	0.52	7.05	....	13.77	....	....	1.14
Kan. City, St. Jo. & Council Bluffs	....	...	....	61.80	13.76	4.45	5.58	4.94	0.10	0.18	5.83	....	16.63	....	....	1.88
Lake Shore & Mich. South	61.08	85.36	36.20	63.77	....	....	3.13	5.11	0.16	....	6.91	0.19	15.52	....	....	1.59
Louisville & Nashville	62.64	108.16	60.44	80.54	12.69	6.72	5.03	6.53	0.27	1.49	6.12	0.65	20.09	3.33	1.58	1.62
Manhattan Elevated	....	....	....	43.67	....	....	2.50	8.80	0.30	....	8.70	....	20.30	...	..	4.03
Mexican Central†	...	....	....	61.05	....	....	5.68	15.35	0.40	0.15	5.92	1.01	28.55	....	....	5.60
Mil., L. S. & West	...	....	....	78.64	....	....	4.46	11.75	0.24	....	6.15	0.96	23.56	....	....	3.00
Minn., St. P. & Sault Ste. Marie	...	....	...	66.78	....	....	3.72	11.16	0.21	....	6.34	...	21.43	....	1.86	4.17
Missouri Pacific	....	....	....	80.5[illegible]	18.41	5.67	4.67	5.76	0.34	1.19	6.48	1.51	19.96	4.73	1.37	1.41
N. O. & Northeastern	63.09	114.93	31.95	71.17	....	....	4.50	7.40	0.28	0.60	6.20	1.70	20.68	....	...	....
N. Y., Lake Erie & West	87.10	128.90	69.10	....	18.70	5.80	4.06	7.04	0.40	2.28	7.10	1.11	21.99	....	1 57	1.30
N. Y., Pennsylvania & Ohio	84.30	137.80	77 80	....	16.00	7.60	3.32	6.75	0.31	1.67	6.81	0.98	19.84	...	1.61	1.15
N. Y., Prov. & Boston	...	...	....	52.31	....	....	2.61	10.01	0.55	....	6.19	0.88	20 24	....	....	....
Norfolk & Western, Gen. Eastern Div.‡	...	....	....	100.00	....	...	6.80	4.10	0.80	....	....	....	11.70	....	....	....
Durham Division‡	...	....	....	51.54	...	...	2.20	7.20	0.40	....	....	....	9.80	....	....	....
Radford Division‡	....	....	....	139.[illegible]3	....	...	11.80	5.50	0.80	....		....	18.10	....	....	....
Pulaski Division‡	....	....	....	101.52	....	....	5.70	4.10	0.80	. .	...	....	10 60	...	....	....
Clinch Valley Division‡	....	....	....	125.00	....	....	9.10	5.00	1.00	...	...	....	15.10	...	....	...
Ohio & Mississippi	....	...	....	80.97	....		4.10	3.53	0.26	1.21	5.47	1 48	16.05	....	....	0.84
Old Colony	....	...	....	57.44	....	....	4.00	10.77	0.64	. ..	6.85	0.83	23.09	....	....	3.75
Philadelphia & Reading	....	... .	....	81.67	....	. ..	4.53	4.65	0.35	....	5.76	0.42	15.71	..	...	....
South. Pacific, Pacific Sys.	....	....	....	67.70	...	....	5.48	18.66	0.38	1.81	7.27	1.90	35.50	..	....	5.70
Union Pacific	...	....	..	100.60	1[illegible].63	8.44	8.02	10.15	0.44	0.96	8.07	1.25	28.89	4.70	2.26	2.01
Vicksburg, S. & P.	47.84	80.32	28.33	53.76	....	....	3.80	7.10	0.30	0.90	6.30	[illegible].60	21.10	....	....	....
Wabash	....	..	....	83.02	13.44	6.03	3.30	4.83	0.29	....	6.22	0.89	15.53	2.68	1.03	1.16
Wisconsin Central	..	....	....	81.93	...	....	3.42	9.73	0.24	....	7.30	....	20.69	...	...	2.31

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 17.2 units of work per $1 of expense; 177.5 units of work per ton of coal; 11.3 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

boxes, preferred to work thirteen hours night shift and eleven on a day, changing about. The work of station-masters and porters varied very much. At a large station it was so excessive that they were not called upon to work long hours, but at small roadside stations the hours were longer, though there were more intervals of rest. With regard to these intervals of rest, he did not think a short interval was worth much, although the aggregate might amount to several hours, but a rest of four hours would be worth a good deal if the man could get away from his engine or train.

He was in favor of the Board of Trade using all the powers they had got to bring about a reduction in the hours of work.

The number of cases of accident where the Board of Trade had ascertained that the railroad servants had been employed very long hours when the accident occurred was ten in 1888; eleven in 1889; fifteen in 1890, and twelve in 1891.

UNIFORM REPORTS OF LOCOMOTIVE PERFORMANCE.

THE following is the report submitted to the Master Mechanics' Association by the Committee on Uniform Reports of Locomotive Performance; it is signed by Messrs. George F. Wilson, J. S. McCrum, John Player, James McNaughton and John A. Hill:

Your Committee, appointed to investigate the subject of uniform locomotive performance statement, beg to submit the following:

First. We would recommend that all passenger and freight mileage be based on actual miles run, and 5 per cent. to be added to all freight mileage; that all engines in construction or snow-plow service be allowed at the rate of 10 miles per hour; all engines in switching service be allowed at the rate of 8 miles per hour, no percentage to be added to this class of mileage. All other runs of less than 100 miles, freight or passenger, actual miles to be allowed, regardless of what engineers and firemen may be paid for such service. No extra mileage should be allowed going to and from the round-house. When an engine is assigned to more than one class of service, the mileage should be computed, so as to show each class of service.

Second. In the distribution of fuel one cord of wood should be rated as one ton of coal, and all expense in connection with the handling of fuel, either wood or coal, to be included in the cost of same; all coal to be rated at 2,000 lbs. per ton.

Third. In the distribution of illuminating oils, only such oils as are used in the head-lamps and lamps and torches belonging to engines should be shown on the performance sheets.

In the distribution of lubricating oils, we believe all oils used in lubricating engine, including that used in packing driving-boxes, tender, and engine trucks, while engine is undergoing general repairs, should be charged to repairs. All lubricating oils used on engine after engine goes into service, to be charged on cost and performance sheets as lubricating oil against engine.

Fourth. In showing the miles run to one pint of oil, the engine, valve, and illuminating oil should be separated, showing the miles run to one pint of each, and a separate column be made on engine's statement, giving the total average for all kinds of oil.

All waste used by engineers and firemen, and by wipers for wiping engines, should be shown on performance sheet, and the miles run to one pound of waste given. Waste used on engines while undergoing repair should be charged to repairs.

Fifth. In the apportionment of the expense of labor for repairs of engines, we believe no labor should be charged for repairs other than performed by mechanics, helpers, and those actually working on repairs; laborers, sweepers, sanding and turning table, cleaning round-house and other outside work in and about round-house, should not be charged to repairs, but should be charged to locomotive service.

All undistributed labor, such as superintendence, clerks, etc., should be prorated over general shop expense. Cost of engine repairs, caused by accident due to other than engine failures, to be not shown on performance sheet, but such expense should be kept separately, and charged to the department responsible for the accident.

Sixth. All new engines purchased or built to take the place of those worn out should not be charged to repairs of locomotives. All general repairs of engines, including overhauling, etc., except the above-mentioned, to be charged to repairs, except the application of new devices, such as air-brake equipment, extension front end, steam-heating appliances, train signal, or smoke consumer. We believe the application of these new devices should be charged to new equipment or betterment. In the charges for materials used on engines, including files, chisels, other small tools, and the engine's equipment, should be charged to repairs of engines. We would recommend the preparation each month of a performance sheet in detail for each division of the road, the same to contain the following information:

Engine No.
Name of engineer.
Name of fireman.
Mileage, each class separately.
Mileage, total.
Tons of coal.
Cords of wood.
Oil, each kind separately.
Waste, pounds.
Cost of coal.
Cost of wood.
Cost of oil and waste.
Wages of engineer and fireman.
Wages of hostler, wiper, and miscellaneous labor.
Cost of material for repairs.
Cost of labor for repairs.
Cost, total.
Cost per mile run for fuel.
Cost per mile run for oil and waste.
Cost per mile run for engineer and fireman.
Cost per mile run for hostlers, wipers, etc.
Cost per mile run for repairs, labor, and material separately.
Total cost per mile run.
Miles run to one ton of coal.
Miles run to one pint of engine oil.
Miles run to one pint of valve oil.
Miles run to one pint of lubricating oil.
Miles run to one pint of illuminating oil.
Miles run to one pint of all kinds of oil.
Miles run to one pound of waste.
Average number of loaded cars hauled per train.
Average number of pounds of coal consumed per car per mile.

To place the rating of empty cars on a uniform basis, your Committee would recommend the following:

In figuring loads, all box, stock, refrigerator, and furniture cars, 30 ft. long or over, three empties to be considered equal to two loads; gondola and flat cars, two empties to be considered equal to one load.

The Railroad Puzzle.

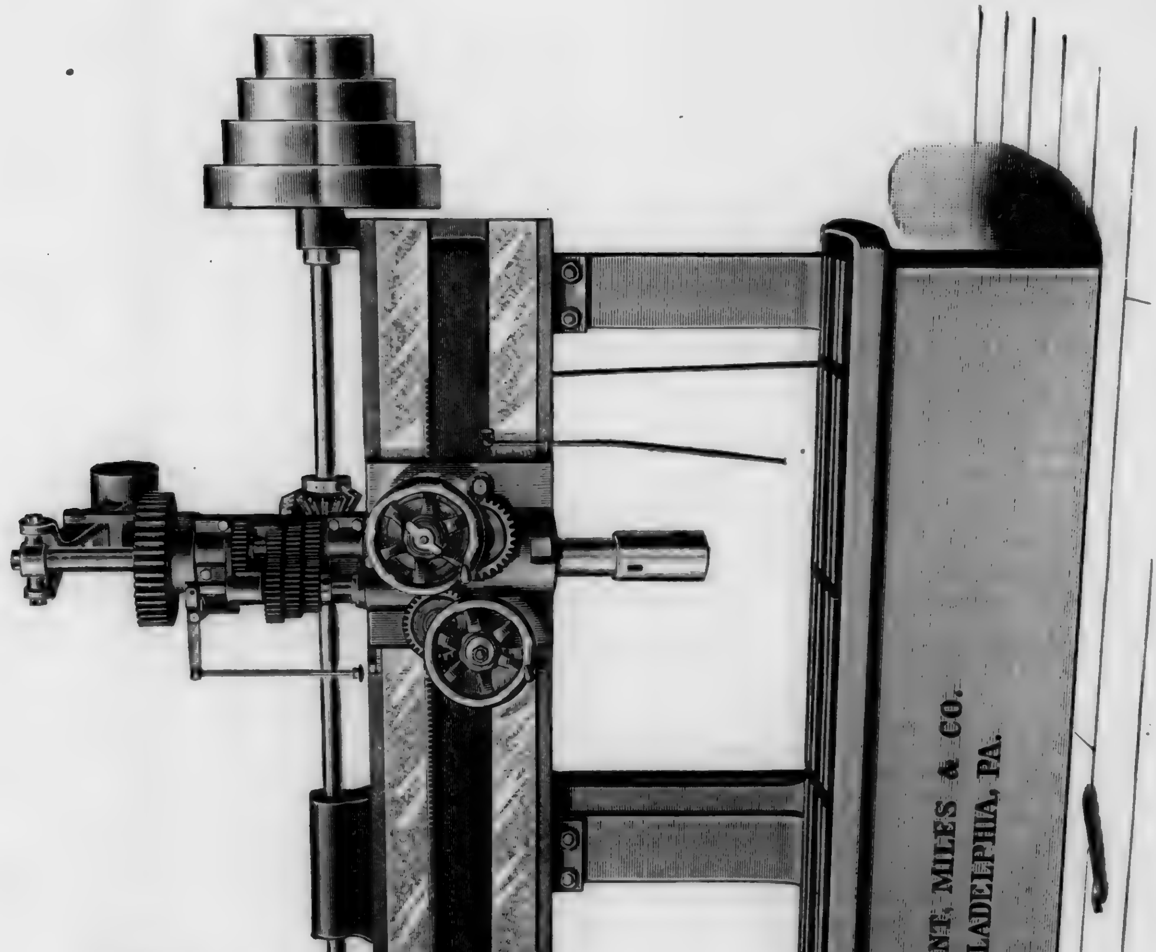
IN the July number of the JOURNAL, page 332, there was published the following:

RAILROAD PUZZLE.

The "new and useful improvement in puzzles," illustrated by fig. 6, has been patented by Mr. J. C. Jackson, of Greenville, Pa.

The problem presented is to place the locomotive and cars as shown, run the locomotive around the **Y** to reverse it, and leave the cars as they were found—3 at *F*, 2 at *B*, and 1 at *C*.

In the solution of the problem what is known as "running switches" are not allowed. The cars can only be pushed or pulled by the locomotive. Neither can but one car or the locomotive alone be upon the spur *D* at one time. Neither can more than two cars or the locomotive and one car be upon the main track at the left of the **Y**, as at *E*, at one time. The

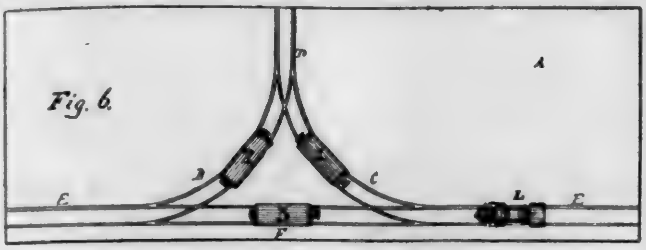


TWO-SPINDLE DRILLING MACHINE FOR LOCOMOTIVE CONNECTING RODS.

MADE BY BEMENT, MILES & COMPANY, PHILADELPHIA.

main track between the branches of the **Y** will hold the locomotive and one car.

As then promised, we give herewith the solution contained in the specification of Mr. Jackson's patent. We may mention also that correct solutions have been sent in by three subscribers—Mr. Thomas Wright, of Luzerne, Pa.; Mr. Thomas



JACKSON'S RAILROAD PUZZLE.

H. Wigglesworth, of Denver, Col.; and Mr. H. J. Kennedy, of Lutherville, Md.

The answer given by the inventor is as follows:

SOLUTION OF THE PUZZLE.

Place the locomotive and cars as seen in the drawings, the locomotive *L* on the main track *E* at *e* with the pilot pointed toward the **Y**, car 3 on the main track between the branches *B C* at *f*, car 2 on the branch *B*, and car 1 on branch *C* at *c*. Run the locomotive down the branch *C* and pull car 1 back on the main track and push it down to car 3 on the main track between branches *B* and *C*. Then back the locomotive, run it down branch *C* onto the spur *D* and back up branch *B*, and push car 2 out on the main track at *E'*. Then run the locomotive down the main track, and push cars 1 and 3 out to or beyond *e*. The locomotive then stands on the main track reversed from its first position; but it has yet to make the circuit twice more to complete the solution. Now back the locomotive down branch *C* onto spur *D*, run up branch *B* onto the main track, when the pilot will point in the same direction as when it started first. Then back down the main track and get cars 1 and 3 and pull them on the main track between branches *B* and *C*. Now run on and get car 2 and back with it on branch *B* and leave it there. Then back the locomotive onto spur *D*, run up branch *C* to the main track, back up and get car 1, and pull it out on main track at *e*. Then push said car 1 back on branch *C* and run the locomotive up on the main track, and it is reversed, as desired, and all the cars are left as they were first placed.

New Machine Tools.

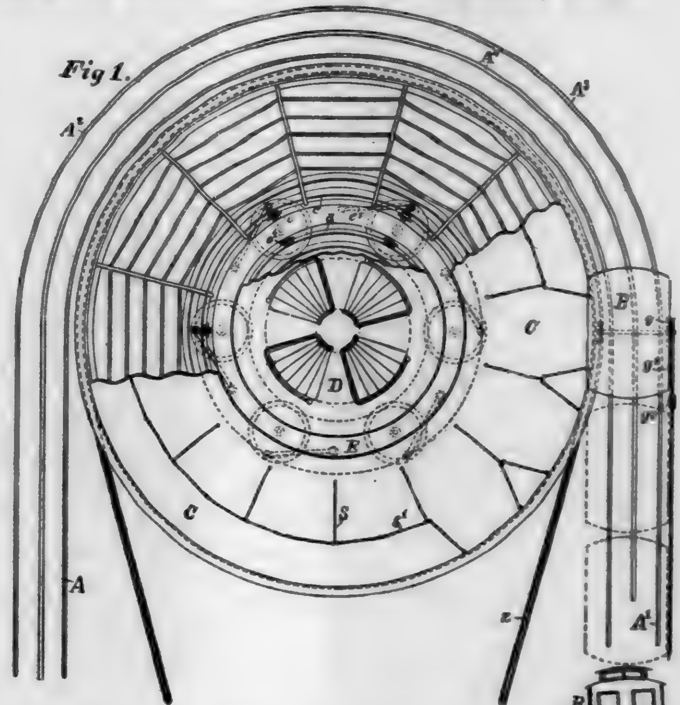
In a previous number some reference was made to the variety of tools made by the works of Bement, Miles & Company in Philadelphia. Among these are included a great number intended for special purposes in locomotive and other shops, and an example of these has been selected for illustration here.

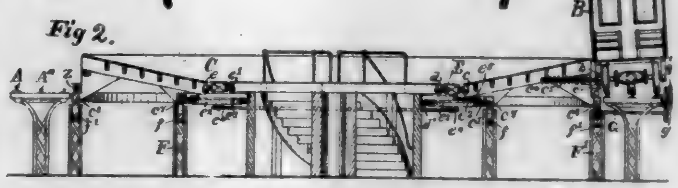
The present engraving shows a special tool which will be very serviceable in locomotive shops. It is a two-spindle drilling machine, designed especially for drilling at one time the holes at both ends of locomotive connecting and parallel rods. It will drill the longest or the shortest rod generally found, the extreme distance between centers being 10 ft. and the shortest distance 3 ft. The power of each head is sufficient to drill a $3\frac{1}{2}$-in. hole in the solid material, and to bore out a 9-in. hole. The spindles are independently driven and have four speeds; three feeds through a distance of $15\frac{1}{2}$ in.; quick return motion; lever counterbalance, and lateral adjustment on the cross-slide by a rack and pinion. Each spindle can be adjusted vertically. The machine is provided with two automatic pumps for lubricating the drills, and the necessary countershafts, etc., are also provided.

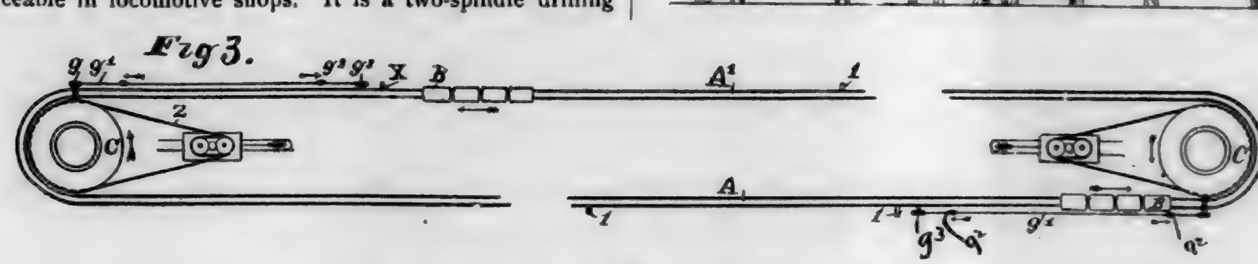
Recent Patents.

REVOLVING PLATFORM FOR TRANSFERRING PASSENGERS TO AND FROM MOVING TRAINS.

The possibility of taking passengers on and putting them off of moving trains has been a subject of a good deal of speculation by inventors. Mr. Charles M. Hollingsworth, of Cleveland, O., has recently patented the ingenious method of doing this, which is illustrated by figs. 1, 2, and 3. In his specification he says: "I have based the construction and intended mode of operation of the circular platform as a means for passing to and from a moving train, primarily, in the fact that the angular motion at the center of a revolving circular platform is *nil*, and increases as the radial distance from the center to the circumference increases. A body supported in such a platform gradually acquires tangential motion in moving toward the circumference, and gradually loses tangential motion in moving toward the center of rotation. Thus we may, if suitable means are provided, get onto a revolving circular platform near the center of rotation without material disturbance to one's balance, and then by moving away from the center gradually and im-







HOLLINGSWORTH'S REVOLVING PLATFORM.

perceptibly acquire the greater movement of the outer edge of the platform.

"As shown in figs. 1 and 2, the platform *C* is in the form of a ring, which surrounds a central stationary platform, *D*. Both platforms are elevated, and a person may reach the stationary platform by passing under the moving platform to stairs which lead to the stationary platform. The platform *C* has on its under side and near its outer and inner edges, respectively, the circular beams c^7 c^8, which serve as tracks and rest upon the friction-rollers *f f*, which are mounted on the columns *F F* arranged in circles about the axis of rotation. The platform is revolved by the driven cable *Z*, which lies in a peripheral groove, or by any other appropriate mechanism.

"Intermediate of the stationary platform D and the revolving platform C is an intermittently movable ring-shaped platform E. On both the outer and inner edges of the platform E is mounted a series of rollers or wheels $e\ e'$, which rest, respectively, on the flange c on the platform C and the flange d on the platform D. By these means the platform E is supported with its upper surface at the level of the proximate edges of the platforms C and D.

"A series of horizontal wheels $e^2\ e^2$, each having a flange e^3, which rests upon flanges c' on the platform C and d^2 on the frame of the platform D, is loosely journaled to a stiff ring e^4. This ring is sustained by its connection with the wheels, and the only function of the ring, as shown in the drawings, is to keep the wheels $e^2\ e^2$ properly spaced at the same distance from each other. Each wheel is connected by means of a pitman, e^5, with the under side of the platform E. The faces of the wheels $e^2\ e^2$ bear on one side against the edge of the flange c' of the platform C and on the other side against the edge of the fixed flange d^2. The friction between the wheels $e^2\ e^2$ and the fixed flange d^2 on one side and the revolving flange c' on the other side cause said wheels to revolve. By reason of the connection above explained between the platform C and the wheels $e^2\ e^2$ said wheels move the platform E intermittently forward in the same direction that the platform C moves. When the pivots which connect the pitmen e^5 with the wheels e^2 is nearest the platform C, as shown in the drawings, the platform E will move fastest and at substantially the same angular velocity as that at which the platform C moves. When the said pivots are nearest the fixed platform D, the platform E is stationary—that is to say, as said points of connection between the wheels e^2 and pitmen e^5 are moving outward the platform E moves with increasing velocity until said points of connection are nearest to the platform C, and after that the platform E moves with decreasing velocity until it becomes substantially stationary for the instant when said points of connection are nearest the fixed platform. The platform E is therefore an intermittently movable platform. When stationary, or nearly so, passengers may pass between it and the fixed platform D. When moving at and near its maximum speed, passengers may pass between it and the platform C. In both cases the passenger passes from one platform to a platform which is relatively fixed, or substantially so."

Fig. 3 shows the arrangement of the tracks in relation to the platforms.

Foreign Naval Notes.

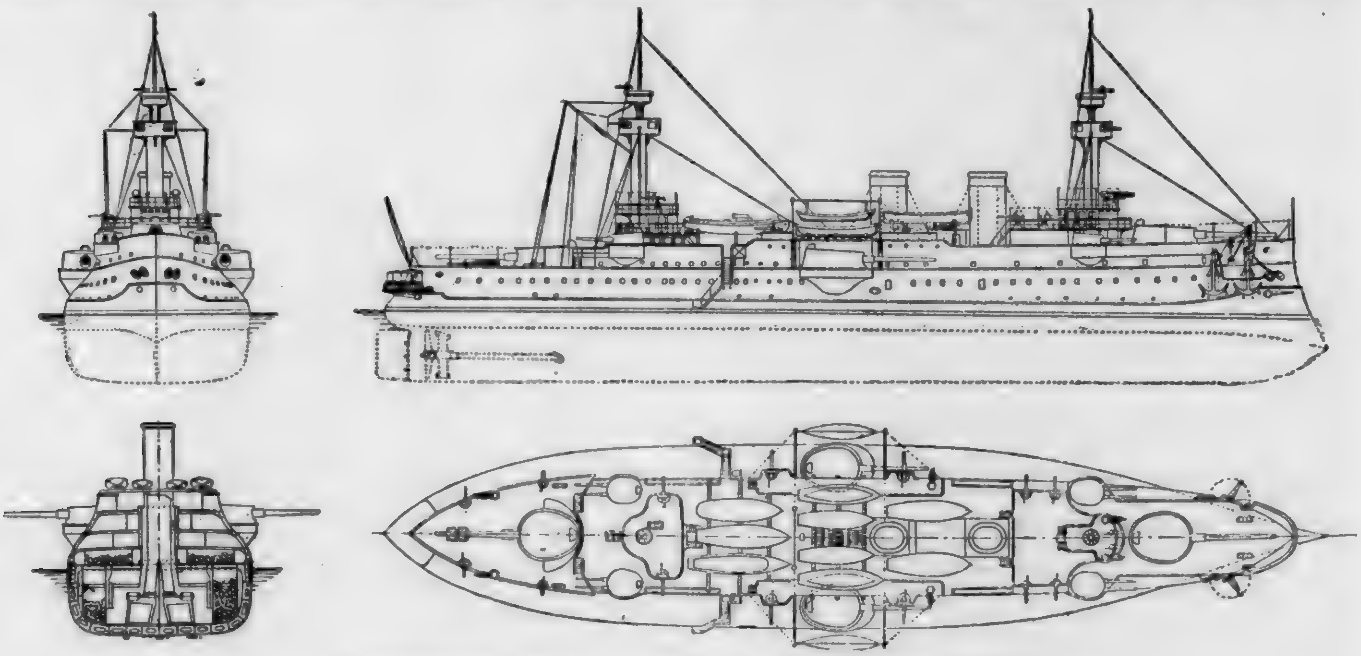
A SPANISH TORPEDO-CRUISER.

The Spanish torpedo-cruiser *Temerario* was recently completed at Cartagena ; she was designed by Don Tomas Tallerie, and is the first of six of the same class, two of the others being now under construction at Carraca and three at Ferrol. The dimensions of the *Temerario* are : Length, 190 ft. ; beam, 23 ft. ; extreme draft, 10 ft. 4 in. ; displacement, 550 tons. She has two torpedo-tubes, and also carries two 12 cm. (4.7-in.) Hontoria guns, four 2.2-in. and one 1-in. Nordenfelt guns.

There are two triple-expansion engines, built by Maudslay, Sons & Field, in London, England. There are two cylindrical boilers and two boilers of the locomotive type. On her trial trip the highest speed with forced draft was 20.5 knots ; the average speed with natural draft was 16.5 knots.

A FRENCH BATTLE-SHIP.

The accompanying drawings, from *Le Yacht*, show an elevated, a deck plan, a front view, and a cross-section of the *Jauréguiberry*, the latest design for a battle-ship for the French Navy. She is now under construction by the Forges et Chantiers de la Mediterranée, at La Seyne. The contract price of the ship, including armament, is $5,172,300. The chief dimensions are : Length, 356.9 ft. ; beam, 72.7 ft. ; depth, 47.9 ft. ; draft of water aft, 27.7 ft. ; displacement, 11,818 tons. She has a water-line armored belt extending the whole length, and varying from 9.8 in. at the ends to 19 7 in. in thickness at the center ; a protective deck 2.8 in. thick ; and coffer dams protected by 3.9-in. plates. There are two large turrets of 14.6-in. plates, and four smaller ones with 3.9 in. plates. All the turrets can be worked by hand as well as by the electric motors which will be provided.



BATTLE-SHIP "JAURÉGUIBERRY," FOR THE FRENCH NAVY.

The armament includes two 30-cm. (11.8 in.) and two 27-cm. (10.63-in.) guns in the large turrets ; eight 14-cm. (5.5-in.) guns in the four small turrets ; four 65-mm. (2.56-in.), twelve 47-mm. (1.85-in), and eight 37-mm. (1.46-in.) rapid-fire guns ; and six torpedo tubes.

The twin screws are driven by two triple-expansion engines, which are expected to work up to 13,500 H.P., and to give the ship a speed of 17 knots. Steam will be supplied by 24 tubulous boilers of the D'Allest type. This is the largest ship which is supplied entirely with these boilers.

Manufactures.

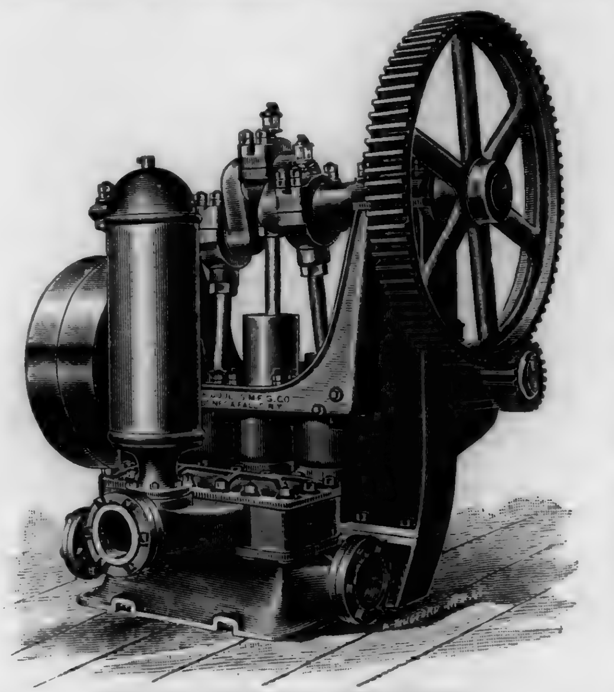
Power Pumps.

The power pump may be defined as one in which the motive power is not a component part, but is transmitted to the pump by belt, gears or direct shaft connection from source of power, such as steam-engine, water-wheel, or electric motor, etc.

To obtain the highest efficiency in power pumps, both in power consumed and general working, it is of primary importance that the discharge be isochronous, or the pump to discharge equal volumes of water in equal times. The reason for this is that when once a column of water is given a certain velocity of discharge it is evident that any deviation from this constant velocity will result in loss of power in overcoming friction and inertia of the moving column. To illustrate : It is proposed to pump against a column of water 6 in. in diameter, 500 ft. vertically. If pumping mechanism is employed in

which this column is stopped and started at every revolution of the pump, it is evident that a large amount of power is consumed in overcoming inertia of the moving water; whereas, if the column of water when once started be maintained at a certain uniform velocity, the power required to overcome inertia of moving water is reduced to a minimum.

Careful consideration will show that the required conditions will best be met by a triple-acting pump, with its cranks set at



GOULDS' TRIPLEX POWER PUMP.

equal intervals or 120° apart. The illustration given shows a pump of this description made by the Goulds Manufacturing Company at Seneca Falls, N. Y., and called by the manufacturers a triplex power pump. As shown in the cut, the cylinder body, containing three independent cylinders and journal-boxes for carrying main shaft, is bolted to a case. Base contains suction valves through which water is drawn from source of supply into pump-chamber, and then upon the descending of the plunger they discharge through valves into chamber connected with the air vessel to discharge pipe. The plungers are of the hollow trunk pattern, fitting exactly the cylinders through which they work. At the upper end of cylinders is the long packing box which contains hemp or fibrous packings, preventing leaking of water around plungers. This is held in position by a gland tightened down at will by a gland-bolt. Crank-shaft is operated by large spur gear engaged by a small pinion which in turn receives its power from the pulleys. The style of valves employed varies with the work which the pump is required to do. For cold water, a rubber valve with leather face is employed; for hot water, the regular standard metal valve, with beveled seat; for pumping thick stock, tar, etc., the ball-valve pattern.

These pumps are made in a number of different sizes, varying from 1½ in. diameter of cylinders and 2 in. stroke up to 9 in. diameter and 10 in. stroke; they are adapted to a very wide range of work, including boiler feeding, filling tanks, creating hydraulic pressure, etc., etc. The pump shown is arranged to run with a belt, but can be used also with an electric motor or other application of power.

A New Triple-Drum Sander.

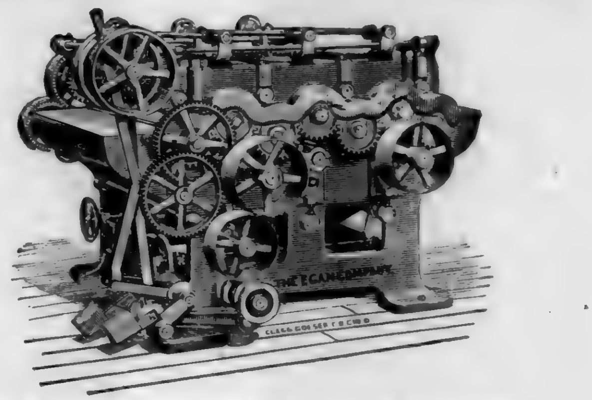
The illustration herewith shows the latest machine of this class, which presents some important improvements. It is made at present in three sizes, 36-in., 42-in. and 48-in., to which 54-in. and 60-in. machines will soon be added. The present tendency is to use wide machines, owing to the change of system in making up furniture, interior, and car work, etc. The wide machines enable the operator to place his stock and feed the same diagonally through the sander. This is indispensable when sanding the cross-rails on stock that is framed up.

The frame is of neat design, made heavy in proportion to the width of the machine. All of the necessary parts are planed perfectly true, and when bolted together make a very solid and rigid frame, capable of standing up to the very hardest kind of work that the machine may be put to, and absorbs any vibrations which may arise in the machine from time to time.

The feed is very powerful, consisting of eight feed rolls of large diameter all heavily geared and made of solid steel and so placed in the machine as to allow very short stock to be sanded. The upper feed rolls are driven by an improved system of expansion gearing, feeding through the machine stock of any thickness from ¼ in. to 6 in. The upper feed rolls and frame are made to raise and lower by power and driven from the countershaft contained in the machine, so that it does not require a separate device to obtain this movement, and it is certainly a very desirable one, taking into consideration that every time a change of paper is made the upper feed rolls and frame must be raised and lowered to put the paper on the middle drum.

The three upper pressure rolls, one for each drum, are made to raise and lower parallel, independent of each other and operated by shafts, gears and hand-wheels, and can be adjusted to suit the different kinds of stock to be finished.

The drums are made of solid metal, having a single fastening device for holding the paper and also for tightening same at any time the operator finds it necessary to do so. Each drum is thoroughly balanced and made with large steel shafts with extra long bearings lined with genuine babbitt. Each drum is made to raise and lower independent of the other and from the working end of the machine, and this is accomplished without stopping the machine. This is a very desirable feature, and not



NEW TRIPLE-DRUM SAND-PAPERING MACHINE.

found on some of the machines of this kind. The last drum is fitted up with a patent brush attachment which is indispensable for fine work. It brushes the dust from the board before it goes through the feeding out rolls. Each drum is made to oscillate at a high rate of speed.

This is a very useful machine for many purposes, including interior finish, car work and similar work. It is made by the Egan Company, Nos. 194–214 West Front Street, Cincinnati.

General Notes.

The new circular lately issued by Mr. Robert A. Keasbey, New York, gives certain reductions in the price-list of his magnesia sectional coverings. The circular contains some interesting statements with regard to these coverings and an account of the method of applying them, illustrated by diagrams. It may be noted here that the demand is rapidly increasing, and a very satisfactory business is reported by the manufacturer.

The Ashton Valve Company announces that it has bought the entire plant, material and business of the Boston Steam Gage Company, together with a series of valuable patents, and has consolidated the business with its own. The company has secured the services of the former manager of the business, Mr. H. L. Willard, long and favorably known to the trade. The Ashton Company will manufacture all classes of steam pressure and vacuum gauges, hydraulic gauges, water pressure and ammonia gauges, and all similar instruments used in connection with steam plants, being more particularly the sole manufacturers of the "Boston Patent" steam gauge.

The Pennsylvania Steel Company has recently added a number of new tools to its machine shops at Steelton, Pa., in order to provide needed facilities for the rapidly increasing amount of work called for.

The Board of Public Improvements of St. Louis will receive at its office in that city until August 9 proposals for furnishing all the materials, constructing and erecting at the water works at Bissell's Point one high-service pumping engine, five boilers and all the appurtenances. Full particulars can be had at the office of the Board.

The St. Charles Car Company, St. Charles, Mo., is building 10 passenger cars for the Vandalia Line.

The New York Car-Wheel Works, Buffalo, N. Y., are very fully equipped with special machinery for making and finishing wheels. In addition to the ordinary work on wheels, at this establishment they are centered, turned true on the tread and balanced. A special department lately added is for wheels and axles for electric motors. The New York office of the Company is now at Bank and West streets.

The Builders' Iron Foundry, Providence, R. I., is now finishing and assembling 43 new 12-in. breech-loading mortars for coast defense. This will make, with the previous contract, 73 of these mortars built for the United States Government.

The Pullman shops of Pullman's Palace Car Company are building 55 passenger cars for the Chicago, Burlington & Quincy Railroad.

The Chattanooga Car & Foundry Company, Chattanooga, Tenn., is making arrangements to build passenger cars as well as freight cars at its works.

The works of the Barney & Smith Manufacturing Company in Dayton, O., have passed into possession of a new corporation organized under the same name. The property is now capitalized at $4,500,000, the issues including $1,000,000 in 6 per cent. bonds, $2,500,000 in preferred stock and $1,000,000 in common stock. There is no change in management.

The Dickson Manufacturing Company in Scranton, Pa., has completed 10 consolidation locomotives for the New York, Ontario & Western Railroad.

The Michigan-Peninsular Car Company is the name of a new concern formed by the consolidation of five Detroit companies—the Michigan Car Company, the Peninsular Car Company, the Detroit Car-Wheel Company, the Michigan Forge & Iron Company and the Detroit Pipe & Foundry Company. The new corporation issues $5,000,000 in 8 per cent. preferred stock, $3,000,000 in common stock and $2,000,000 in 5 per cent. bonds, making a total capitalization of $10,000,000. The combined works have a capacity of nearly 100 freight cars a day.

It is stated that arrangements have been completed to remove the works of the Ingersoll-Sergeant Rock Drill Company to Easton, Pa., where large shops will be erected.

The Cleveland Electrical Manufacturing Company, manufacturer of the American watchman's time detector, has contracted to furnish the Chicago Telephone Company with all the time detectors they will use for the next five years, and has just shipped 100 instruments on this contract. These time detectors all have capacity for 10 stations and are fitted with a movement which revolves once in seven days, so that the dial on which the record is received can be used for a week without changing.

The new catalogue of the Consolidated Car Heating Company, Albany, N. Y., calls attention to several recent improvements in car-heating apparatus. These include:

1. A new hot-water circulating low-pressure system known as the multiple circular drum system, which will work with 4 lbs. pressure. Its application does not break the seal of any water heater, and it can also be used without any water heater.

2. The improved commingler system, noiselessly injecting steam and leaving the water heater always ready for building a fire, if needed. This system will work with 2 lbs. pressure.

3. The dust guard for the Sewall steam coupler. The coupler is always to hang in this guard when not in use, and it takes the place of the chain and protects face of coupler from injury.

4. The special hose nipple for Sewall steam coupler. This special nipple is so designed that it absolutely fixes the position of hose when forced on such nipple, and insures standard length when couplers are repaired by putting on new hose; it is of special value in putting on new hose.

The Delaware & Hudson Canal Company is fitting a number of its passenger cars with the Gould automatic coupler.

The Washburn & Moen Manufacturing Company, of Worcester, Mass., has nearly completed extensive branch works at Waukegan, Ill., whence Western orders will be filled. The new plant will have a capacity of 400 tons a day, and is fitted with all the latest improvements.

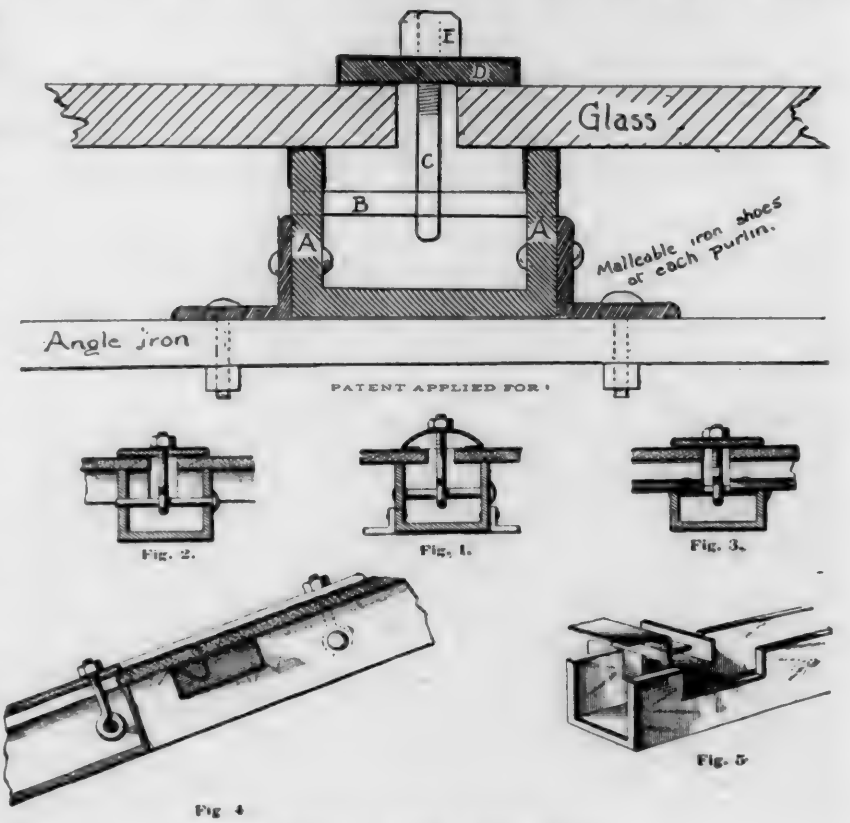
A New Skylight System.

It is well known that the adjustment of skylights and glass roofs has frequently been very imperfect, causing much annoyance from leakage, breaking, etc., and sometimes even preventing the use of glass where it would be very desirable. The accompanying illustrations show a system which presents many advantages, and which seems to obviate the objections made to those generally in use. The larger cut shows the general arrangement, figs. 1–5 giving the details.

This system has been devised and introduced by Messrs. A. Edgcumbe Rendle & Company, of Philadelphia, who have given it the name of the "Paradigm" system.

Referring to the cuts, the astragal or channel bar *A* is made of strong steel, varying in width from 1 in. to 2 in., depending on the distance between the roof purlins to which said astragals are bolted, by means of malleable iron shoes, as shown at fig. 1.

About every 18 in. apart, ¼-in. holes are made in the sides of the astragal bar, into which are secured the cross-bolt *B* and eye-bolt *C*. These bolts secure the glass in place by



THE RENDLE GLASS ROOF SYSTEM.

means of the cap *D* and the brass nut *E*. This cap is made of a bent piece of sheet copper, fig. 1, or narrow pieces of iron covered with copper or lead, figs. 2 and 3.

The new cross or joint-bar of the Paradigm system is made of copper of any sheet metal of the shape shown at figs. 4 and 5. The upper sheet of glass lays on the ledge of cross-bar as shown, and can be set in putty or dry; the sheet of glass immediately below it rests on the edge of cross-bar, and is covered by the cross "cap," which is preferably made of lead or copper.

At the top of the lower sheet of glass, fig. 4, there is a small gutter. In this gutter, every 2 in. apart, ¼-in. holes are punched in the metal before bending. These holes permit any water that may be driven in under the cross cap to drop into the cross-bar, and thus find its way into the main astragal.

Condensation forming on the under side of the glass runs down the glass, and drops into the cross-bar, and so into the main channel bar.

The cross-gutter bars are fitted into slots cut in the steel channel bars, 1½ in. long by ¼ in. deep, as shown at fig. 4, and particularly at fig. 5; and they are made the exact length of width of glass, and lap over main astragal or channel bar, as shown at fig. 5, so that all rain water or condensation finds its way into the main channel bar.

For vertical glazing, the Paradigm system is unsurpassed. Sides and ends of railroad depots could be glazed in this manner very readily, with advantages that are apparent.

With this system it would seem almost impossible for the roof to get out of order; and in case of breakage of glass the broken plate can be very easily replaced.

A New Lubricator.

THE illustrations here given show the lubricator made by the Automatic Lubricator Company, New York, for use in car and locomotive axle-boxes. Fig. 1 is a longitudinal section of a journal-box and fig. 2 a cross-section, while fig. 3 shows one of the lubricating pads on a larger scale.

The lubricator, it will be seen, is a pad which is held up against the lower side of the journal by a spring, and is provided with a wick to draw up the oil. The pad is of such

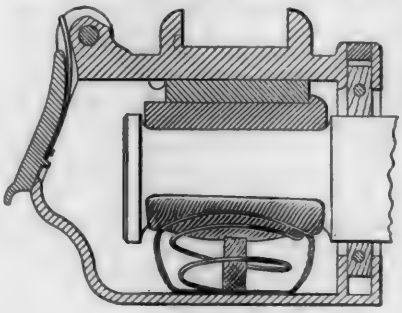


Fig. 1.

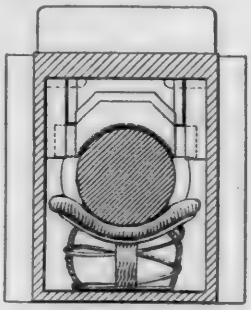
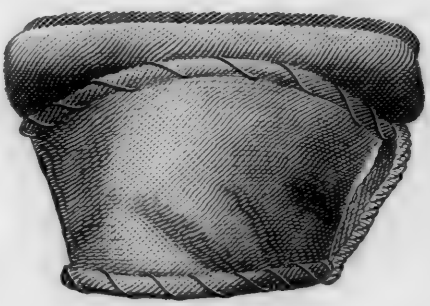


Fig. 2.



THE AUTOMATIC LUBRICATOR.

Fig. 3.

material that it will remain saturated as long as there is any oil in the box, while the surface will not glaze or harden by friction. It can be very easily and quickly put in place and will remain constantly in the proper position after it is placed in the box.

On the Staten Island Rapid Transit Line, where a number of these lubricators have been in use, the cost of keeping boxes in order is reported at 1½ cents per month, against 7½ cents with boxes packed with waste and oil, and tests on other roads have shown a great saving. The average life of a pad has been shown to be about 18 months on cars in constant use. It may be mentioned that the New York, New Haven & Hartford Company has applied these pads on all its locomotive and tender journal-boxes, having nearly 8,000 of them in use.

Baltimore Notes.

THE engineers in charge of the Baltimore Belt Railroad tunnel report the amount of tunnel completed in the different shafts to July 15, as follows: Preston Street, 1,088 ft.; Madison Street, 1,144 ft.; Franklin Street, 765 ft.; Saratoga Street, 953 ft.; German Street, 1,271 ft.; Howard Street covered way, 58 ft.; making a total of 5,279 ft., or practically a mile. This makes a continuous stretch of tunnel from the north head of the Franklin Street shaft to the south side of Lombard Street, a distance of 3,047 ft. There yet remains to be completed 792 ft. The work is being pushed with all possible despatch.

THE Baltimore Electric Refining Company has contracted to enlarge its plant at Canton, so that its tankage or capacity will be doubled. The additions and changes will be completed in the early fall, when the company expects to be able to treat 4,000,000 lbs. of copper ore or matte per month. The company now employs 150 men, which number will be largely increased. Just one year ago the company was organized for refining and separating metals by electrolysis. The officers are Samuel Keyser, President, of New York; R. Brent Keyser, Vice-President and Treasurer, and Joseph Clendenin, Jr., Secretary. The plant was located on Fourth Avenue, Canton, in proximity to the Works of the Baltimore Copper Smelting Company. The interests of the two companies are closely allied and they are also connected with the great Anaconda copper mine in Montana. The doubling of the capacity of the Baltimore Electric Refining Company is due to the decision of President J. B. Haggin, of the Anaconda mine, to have the entire output of the mine refined in America instead of in Europe, and it has been arranged to have the product of the mine undergo the electrolytic treatment at Baltimore. The silver and gold obtained from the Anaconda ore constitutes an important element in the value of its output, and hereafter it is proposed to extract the precious metals before marketing the copper. The output from the Anaconda mines is for the present to be reduced, but it is said that the treatment of all the material in America instead of sending a large part of it abroad in the form of argentiferous matte or ore will add largely to the employment of labor at the smelting and refining works, and thus compensate for the reduced force at the mines.

THE contract for cabling the Blue Line of the City Passenger Railway Company has been awarded to Edmund Saxton, who has built a number of cable roads in Washington and other cities. The Blue Line will be built in substantially the same manner as the Red and White Lines of the same Company are now being constructed. The yokes and rails are being distributed on St. Paul Street, beyond North Avenue. Mr. Saxton says the work on Charles Street will be finished during the summer, while many of the residents along that street are on their summer trips. Mr. John Waters, Superintendent of Construction of the Charles Street power-house, has begun the excavation for the building. It is expected to have the Blue Line cable in operation before the end of the present year. The Gay Street tracks for the Red Line cable are being constructed. The East Baltimore part of the White Line is nearly finished. The Red Line tracks are laid easterly to Eutaw Street, and the White Line tracks are finished from Druid Hill Park to Fayette Street. The part of the road next to rebuild is along the crowded part of Baltimore Street from Eutaw to Exeter Street. As much of this work as possible will be done during the night.

THE Belt Railroad officials some time ago accepted a proposition of the Thompson-Houston Company to give a trial to an electric motor, which that company claimed could generate sufficient power to haul trains through the tunnel without the use of steam. In addition to supplying motive power for the trains, the plant to be built will have capacity and appliance to furnish electric light for all the Baltimore & Ohio buildings in the city, including those at Locust Point. This change in the plan will necessitate a change in the location of the electric plant. The original intention was to build in the neighborhood of the Bolton lot. This has been abandoned, and the company are looking for a location in the neighborhood of Camden Station or the new Belt depot. Mr. W. H. Knight, of the Thompson-Houston Electric Company, is in Baltimore looking for a suitable location for the power house which the electric company will build to operate trains in the Belt tunnels; also as to proper water supply. For the boilers artesian wells will be sunk, and will give sufficient supply. These wells are impracticable, however, for the supply needed for condensing purposes, which requires a large volume. Mr. Knight thought he might secure his supply from the basin, but abandoned this idea when he saw the foul condition of the water in the summer. It has been suggested that a sufficient supply can be obtained from near the mouth of Gwynn's Falls, and this suggestion will probably be adopted. The motor the electric light company is building to haul the heavy trains through the tunnel will be 80 tons in weight.

THE Baltimore & Ohio Company has just closed a contract with the South Baltimore Car Works, Curtis Bay, Baltimore, to thoroughly repair 100 of their Wickes refrigerator cars.

THE South Baltimore Car Company is arranging plans for building shops for the construction and repairs of passenger cars. The shops will be of the latest design, and equipped with improved machinery. The shops will be located at Curtis Bay near their present freight-car shops.

THE Edge Moor Iron Works, Wilmington, Del., have taken a contract to build 11 new iron bridges for the New York, Susquehanna & Western Railroad.

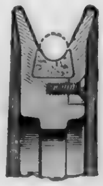
THE Lake Roland Elevated Railroad has let the contracts for the construction of the greater part of the line. The contract for laying the track was awarded to the Duplex Railroad Company of New York. This is a new form of construction, and is all of metal, even to the ties. The duplex rails have no joints, and the whole framework of rails, plates and ties are bolted together, making a very rigid and stable track. The weight of double rails is about 72 lbs. to the yard. All but the elevated portion of the road is to be completed within 90 days. The elevated portion is expected to be finished by October 1. The contract for the electric equipment was let to the Thomson-Houston Company, for motors, dynamos, and generators. The overhead equipment will be supplied by John G. White & Company, of New York. The contract for the motors is for the largest size ever built for street railroad service. Each car will carry two 30 H.P. motors. The cars will be capable of carrying two trailers, and they will move so steadily a change in grade will hardly be perceptible, and they will move at the rate of 20 miles per hour. The passenger cars will vary from 18 to 34 ft. in length, and their seating capacity will vary from 25 to 50. The contract for engines and boilers was awarded to the Corliss Engine Company, of Providence, R. I. They will be of the compound condensing tandem type, with 1,400 H.P., and, as the site of the power house will be at the point where Stony Run empties into Jones's Falls, the Company will have sufficient water. At this place the Company has about one acre of ground. For the overhead construction a metallic circuit will be used, and an unusually large copper wire will be used to feed the motors. This will have the effect of giving an even voltage. The Roland Park Company will erect upon the highest point within its grounds a water tower 70 ft. high, 20 ft. in diameter, and encircled by a spiral staircase of 105 steps 3 ft. wide. The whole structure will be of steel, and have capacity for 165,000 gallons. The contract to build it has been let to Riter & Conley, of Pittsburgh, for $8,000. The spiral stair-case will be lighted to the top by electric lights, and at the summit of the tower will be a balcony covered with a pagoda top and surmounted with a weather-vane. The water will be pumped into the tower by the large springs in the park, one of which has a daily flow of 25,000 gallons. The pump will be operated by electricity from the railroad. The building to be erected for the power station will be 60 × 125 ft., with provisions for extending it to a length of 180 ft. It will be of brick, with an iron roof, and two stories in height. The boilers, engines and generators will occupy separate portions of the main building. The floor of the engine-room will be 7 ft. above that of the boiler-room, so as to allow all of the steam pipes to run under the flooring and out of the way. The elevated portion of the road will be wholly of steel. The girders and braces will not obstruct the light, and yet be sufficiently close to make the structure as strong as it can be made. Stations will be built at Franklin Street, convenient to travelers on the Northern Central by way of Calvert Station, and at other points along the structure.

A New Rope Pulley.

THE accompanying illustrations show a sheave or pulley for wire ropes and cables devised by Mr. William F. Buswell. These pulleys have been furnished to some of the principal cable railroad lines in San Francisco, and have the feature of a hard wearing surface, without much departing from the common section and proportions for such sheaves. The following from Mr. Buswell's patent specification will explain the nature and objects of the system:

"My invention relates to pulleys or sheaves, especially such as are employed for wire rope under heavy strain, as in the case of traction cables for street railroads or in transmitting power by means of wire ropes or cables, and consists in constructing such pulleys or sheaves with a series of inserted segments, forming the bottom or wearing part of the groove or grooves in which the cables bear; the segments being of chilled iron, steel, or other hard material, and so inserted and held as to be removed or replaced in whole or in part without disturbing the pulley or sheaves, and while the rope is in place.

"The object of my invention is twofold—mainly, to avoid wear of the main parts of the sheaves or pulleys by inserting the portions embraced by the cable and subject to abrasion and wear, also to some extent to obviate wear of the cables or ropes which occurs when they bear on soft iron that retains sand or grit."



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BUSWELL'S PATENT ROPE SHEAVES.

The patentee states that with carefully made patterns the hard segments, made of chilled cast iron, steel, gray iron, or other hard material, can be inserted in a very complete manner, and the rim, when filled and closed by the side-plates, is, of course, safe from any accident or derangement such as may happen to built-up wheels or sheaves. The hard sections can be removed or replaced while the wheel is in position, and without removing the ropes, by taking off the side plates which are a little longer than the inserted sections.

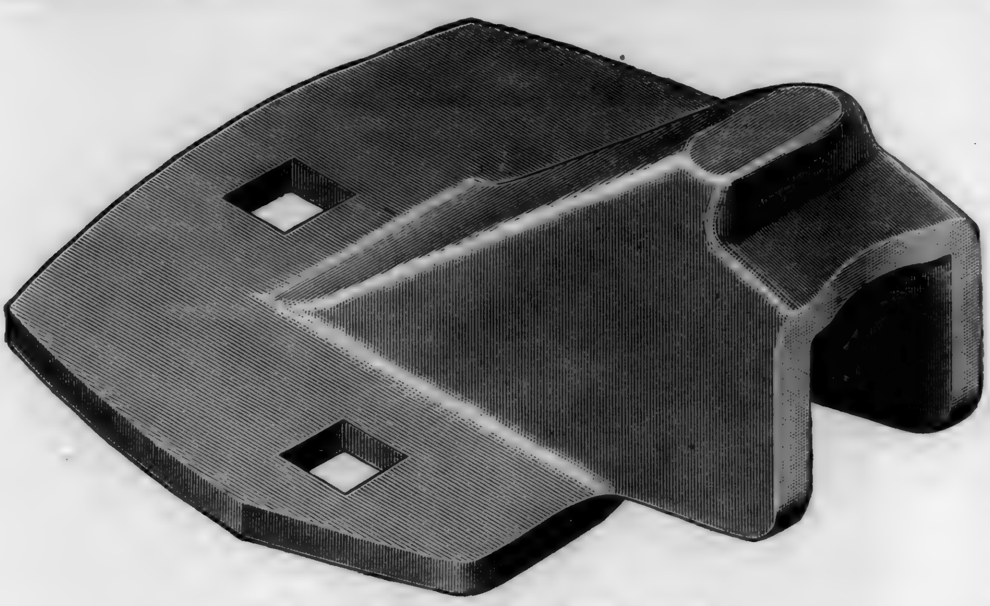
In the details shown, fig. 1 is a section of the rims for a single rope. Figs. 2 and 3 show sections of the inserted sections for a number of ropes or wraps, the construction of the sheaves being otherwise the same as for a single rope.

One would scarce expect that in the development of cable or rope gearing any difficulty would arise in so simple a thing as sheaves or pulleys, but their wear when exposed to grit and dust has called for a good deal of search and experiment to keep down the expense of maintenance, and such experiment has been in the direction of hard material. In the present case this end is attained because the chilled sections, being cast independently, can be as hard as metal can be made.

A Steel Rail-Brace.

THE accompanying illustration shows an excellent rail-brace formed by a die from steel plate. These braces are made of homogeneous steel, ¼ in. or $\frac{5}{16}$ in. thick, as may be preferred, and are so shaped as to have parallel vertical sides. These vertical sides are bridged across under the head of the rail to strengthen them at the point where the brace engages the under and outer side of the rail-head. The shape adopted gives a very strong and rigid brace with a moderate thickness of material. Being of a box form, it fits over the spike in the tie, and it is secured by three spikes. The spike holes in the foot-plate of the brace are left open on one side or entirely surrounded by metal, as may be preferred; the brace itself can, of course, be made to suit any height or size of rail.

The form adopted for this brace prevents the rail from canting entirely, as the head is supported underneath, as well as the flange and web; the strain on the spike on the inside flange of the rail is thus entirely removed. The brace being of steel will last an indefinite time, and cannot be broken in spiking



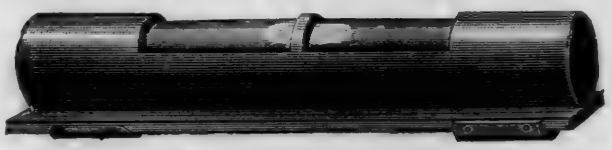
THE WEIR PRESSED STEEL RAIL BRACE.

down, as cast-iron braces often are. At the same time the method of manufacture enables the makers to furnish them at a low price.

These braces are made by the Weir Frog Company, of Cincinnati. We are informed that nearly 2,000,000 of them are now in use on different railroads, showing that they are well appreciated. The roads using them includes such lines as the Boston & Maine; Baltimore & Ohio; Pennsylvania Company; Illinois Central; Louisville & Nashville; Chicago & Northwestern; Chicago, Rock Island & Pacific; Atchison, Topeka & Santa Fé; Union Pacific, and the Northern Pacific.

An Engineer's Tape Level.

The accompanying illustration shows a little device invented by Mr. Ernest McCullough, a California engineer, the use of which will readily be seen with very little description. It is a



McCULLOUGH'S TAPE LEVEL.

small level intended to be attached to a surveyor's tape about 8 or 10 in. from the end. In measuring a distance of 15 ft. or less with the proper tension the bubble of the level should be in the middle, but for greater distances an allowance must be made for the sag of the tape. In practice this can be readily ascertained by trying the tape on the surface known to be level, and marking the position of the bubble on the tube for distances of 25, 50 and 100 ft. In measuring, when the bubbles come opposite these marks the ends of the tape are at the same height. The level should be on the forward end of the tape when dragging chain in going uphill, and on the rear end in going down. Some engineers prefer a level on each end. The cut shows the device full size, and its weight is only 1 oz. It is used by clamping it to the tape by means of the two strings underneath, and can be attached or detached instantly.

This device has been meeting with great favor wherever used, and is recommended as a very convenient addition to an engineer's outfit.

Pennell's Water-Purifying Plant.

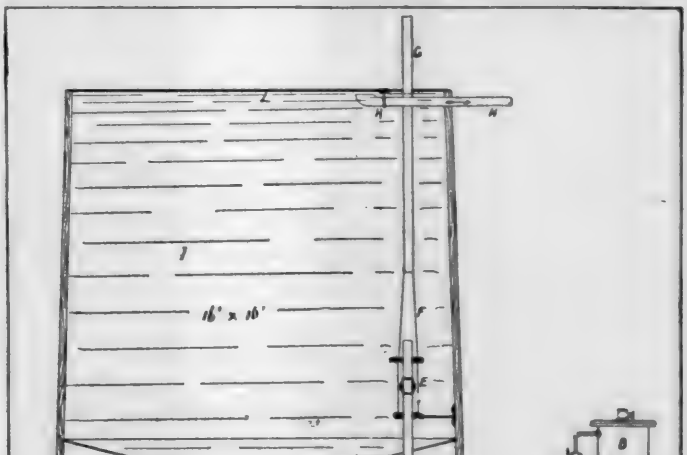
The importance of purifying the water used in locomotive and other boilers has long been recognized. The most important impurities are the scale-forming salts which exist in various forms in what is generally known as hard water. Boiler scale most generally consists of the carbonates and sulphates of lime and magnesia, which are found in varied quantities in almost all of the water in the Middle and Western States, wherever calcareous rock is found, mixed with vegetable matter or mud that may be in suspension in the water.

When water containing these scale-forming salts is used in a boiler, the pure water evaporates, leaving the salts behind. If we know the amount of water evaporated in a given time and have a chemical analysis of the water, we can judge approximately of the amount of solid material which remains in the boiler, and which gradually settles down and forms hard scale, generally on the fire-box sheets, the tubes and other portions of the boiler which are most directly exposed to heat.

The ordinary mud or residuum found in dirty water can generally be disposed of by settling, but frequently an apparently bright, clear water is found to be hard, owing to the presence of carbonates of lime or magnesia in solution. The most direct and simple method of purifying such waters is by the addition of a sufficient amount of slacked lime to the water to combine with the carbonic acid. The carbonates will then precipitate, giving a clouded appearance to the water, and in a given time will settle.

The accompanying drawing shows an arrangement for purifying water, which has been devised by Mr. Arthur Pennell. The drawing shows a plan arranged to work in connection with an ordinary tank 16 ft. in diameter and 16 ft. depth. A closed iron tank *B* is placed in any convenient position alongside the feed-pipe and connected with it by an inlet-pipe entering at the bottom, and an outlet-pipe *D* returning from near the top of the tank. Between these two a gate-valve *C* is placed on the feed-pipe. By partially closing it any desired percentage of water can be compelled to pass through the chemical tank *B*, and there become charged with the lime or other ingredient which may be found necessary to cause the salts in the solution of the water to precipitate. The feed-pipe then enters the settling tank *I*, as shown in the drawing, passing upward through a tee *E*, to the upper end of which is bolted a funnel *F*. The neck *G* of this funnel extends up above the top of the tank so as to carry off any imprisoned air or other gas. The water passes out into the tank through the horizontal limb of this tee, which is so mounted that this horizontal axis is at right angles to the radius of the tank passing through the tee, the result being that the current of water from the feed-pipe imparts a rotary motion to the water in the tank.

Experience has shown that this tee is best mounted so that its horizontal axis is at about one-fourth the height of the tank, permitting the settling to be carried on at the bottom of the tank, while the clear water rises to the surface, whence it



PENNELL'S WATER PURIFYING PLANT.

is thrown off through the outlet-pipe *H*. The capacity of this tank should be sufficient to allow time for the chemical combination to act, and the precipitate form and deposit, and for this purpose account must be taken of the maximum demand for water. The rotary motion imparted to the water in the tank assists the mixing of the particles and hastens the action.

It is considered that the capacity of the tank should be at least three times as great as the maximum hourly demand for water, and if it could be increased to four or five times, it is better. A false bottom, *J J*, which may be either of light boards or sheet-iron, assists the sediment in finding its way to the center of the floor of the tank, where it will settle down over the opening of the waste-pipe *K*, whence it can be flushed away as often as required.

In using this plant it should be borne in mind that the amount of scale-forming salts in any water supply will vary with the season of the year and the weather, and the amount of ingredients used in the chemical tank should be varied so as to correspond as nearly as possible. This is especially the case where the water supply is taken from a river. For example, it has been found by actual test that in water taken from the Missouri River in the month of January, there were 13 grains of carbonates and 11 grains of sulphates of lime and magnesia per gallon; while during the June freshet there were only about three grains of each per gallon, but there was a large quantity of mud in suspension. In the first place, the chemical ingredients needed were about 1½ lbs. of slacked lime and 1 lb. of soda ash per thousand gallons of water, whereas in the latter case ½ lb. of caustic soda and ½ lb. of potash alum would do the work.

It is hardly necessary to state the advantages obtained by purifying the water from the bulk of the scale-forming salts. When this is done the water entering the boiler will contain a certain amount of residuum, but it will not be the salt matter which forms a hard scale, but simply loose slush, which can readily be blown off. It may be said also that there is a great advantage in ascertaining the composition of the water and in being able thus to treat it intelligently.

For railroad work this device can be attached to existing supply tanks. The arrangement of the outlet-pipe *H* near the top of the tank is considered important, and would in fact be desirable in any tank, as the water near the surface will always be clearer than that at the bottom.

This system has been tried on the Union Pacific with very satisfactory results, and is now being introduced on other roads by the inventor.

The Stow Flexible Shaft.

THE accompanying illustration shows, in fig. 1, a section of the flexible shaft invented by Mr. Nelson Stow and made by the Stow Manufacturing Company, and in fig. 2 one of the numerous applications which can be made of this shaft. The

FIG. 1.—STOW FLEXIBLE SHAFT

FIG 2.—STOW CENTER GRINDER

success of this device within a few years is another illustration of the fact that a really useful tool is sure to make its way. It has taken position as a standard tool, and is in use in a very large number of shops all over the country.

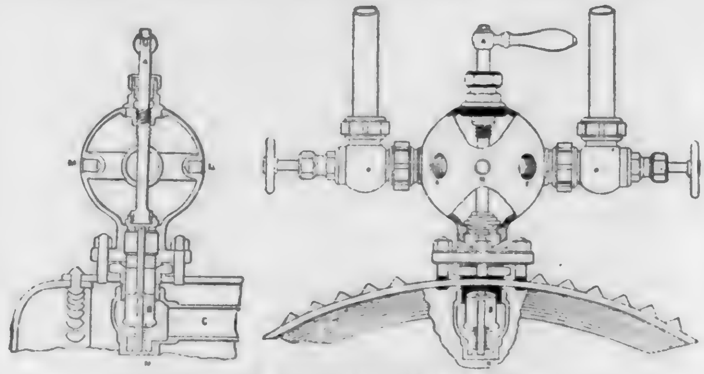
The application shown in fig. 2 is of a center grinder. This consists of a 3½-ft. flexible shaft with the traction pulley at one end, the other attached to a sliding spindle holding a 3-in. emery-wheel. The spindle turns in the tool-post the same as an ordinary tool, and it can be set in place or taken down in a very short time, and with it a lathe center can be ground true very quickly. Numerous other applications can be suggested, which are probably well known to our readers.

The demand for these tools has become so great that the Company has recently taken up its quarters in one of the best-appointed shops to be found anywhere, where many appliances of similar description to that shown above are manufactured as well as the shaft.

The officers of the Company are Nelson Stow, President; C. E. Warner, General Manager, and C. F. Hotchkiss, Treasurer, and their office is at Binghamton, N. Y.

The Detroit Supplemental Steam Dome.

THE accompanying cuts show a very neat device made by the Detroit Lubricator Company, and called a supplemental



HODGE'S SUPPLEMENTARY DOME.

dome. It is intended to prevent the necessity of the numerous holes in the boiler which are usually made for steam connections about the cab.

The dome is located on center of boiler head, and all steam connections are made to it. It is provided with a cut-off valve *A*, having a lever handle, one-half turn of which closes the connection between it and the boiler, enabling the engineer to repair or repack any of the connections without loss of time in allowing engine to cool. The dome is also provided with a security-valve *B*, located inside the boiler, which closes instantly, in case the dome should become detached by accident, and thus prevent escape of steam, and great risk of scalding the engineer and fireman. From five to seven dry pipes are dispensed with by using this dome; and taking steam from a common reservoir, nothing but dry steam can ever be furnished to the different connections.

The ordinary size dome is 9⅝ in. in diameter, and is complete with valves *A* and *B*, as in cut, and is tapped to fit standard connections.

Manufacturing Notes.

AT the Wheeler Yard, West Bay City, Mich., the large steamer *Gilbert* and the light-ship No. 51 have recently been sent away ready for service. The *W. H. Gilbert* is one of the largest vessels ever built in the yard. She is 345 ft. long over all; 328 ft. keel; 42 ft. 6 in. beam, and 24 ft. deep. She has a triple-expansion engine with cylinders 23 in., 37 in. and 62 in. in diameter by 44 in. stroke. Steam is supplied by three boilers, each 12 ft. 8 in. in diameter and 12 ft. 6 in. long. The engines have been built by the Frontier Iron Works, of Detroit.

Wheeler & Company have just closed a contract for another freight boat similar to the *Gilbert*. The general dimensions will be the same, but there will be a slight difference in the motive power. The triple-expansion engine will have cylinders 20 in., 32 in. and 54 in. in diameter and 42 in. stroke. The propeller will be 12 ft. in diameter and 14 ft. 9 in. pitch. There will be two boilers 12 ft. in diameter and 12 ft. long, built for 160 lbs. pressure. The engines for this boat will be built in the Wheeler Works, the machine shops having recently been enlarged so that ships built there can be engined in their own shops.

IT is reported that the Johnson Switch & Signal Company has been consolidated with the Hall Signal Company of New

York. The Johnson Company was organized by Charles R. Johnson some years ago, and controls some valuable patents for interlocking and other signals. It is at present equipping the New York Central line to Mott Haven, and has some other large contracts.

THE St. Charles Car Company, St. Charles, Mo., during the past six months has made large additions to its freight-car plant, and has put in a new stationary engine and a number of tools, increasing the output 8 cars per day. The shops have just completed 1,500 cars for the Atchison, Topeka & Santa Fé, and are now building 1,000 box and 500 coal cars for the Missouri Pacific. The passenger-car plant is also being enlarged to meet the demands made upon it. They are now building an addition which will hold 12 passenger cars. The latest orders received include 10 coaches for the Vandalia Line and 20 for the Northern Pacific. The latest freight order is for 300 cars for the Missouri, Kansas & Eastern road.

Some time ago the Company established a branch shop at Denver, Col., under the charge of the Assistant General Manager, Clarence H. Howard. This shop was established to repair, rebuild, and put in good order a large number of narrow-gauge cars belonging to the Denver & Rio Grande Railroad. This work has been substantially completed, and the branch shop will soon be closed.

PERSONALS.

J. W. SCHAUB has resigned his position as Engineer of the Detroit Bridge & Iron Works.

ROBERT ENGLISH has been appointed General Master Mechanic of the Atlantic & Pacific Railroad.

ALFRED P. BOLLER, the well-known bridge engineer, has been dangerously ill of typhoid fever, but is now recovering.

E. J. PEARSON has been appointed Principal Assistant Engineer of the Wisconsin Central Railroad, with office in Chicago.

A. W. GIBBS, recently with the Central Railroad of Georgia, is now Master Mechanic of the Atlanta Division of the Richmond & Danville Railroad.

THE office of R. D. WADE, Superintendent of Motive Power of the Richmond & Danville Railroad, has been transferred from Atlanta, Ga., to Washington.

D. J. DANELL, for some time past with the Illinois Central Railroad, has been appointed Mechanical Engineer of the South Chicago Works of the Illinois Steel Company.

PROFESSOR J. B. JOHNSON has retired from the firm of Johnson & Flad, Consulting Engineers, on account of the pressure of his duties in Washington University and elsewhere.

J. J. ELLIS has been appointed Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, succeeding MATTHEW ELLIS, who has resigned on account of ill health.

GENERAL V. E. MCBEE, recently with the Central Railroad of Georgia, has been appointed General Superintendent of the South Carolina lines of the Richmond & Danville Railroad.

GEORGE A. HANCOCK, formerly with the Atlantic & Pacific Railroad, is now Superintendent of Motive Power of the San Antonio & Aransas Pass Railroad, with office at San Antonio, Texas.

CHARLES F. STOWELL, for some years past Bridge Engineer of the New York Railroad Commission, has resigned that position and has, with M. C. CLAY and A. C. CUNNINGHAM, formed the American Engineering & Inspection Association, which will have its headquarters in Albany, N. Y.

CLARENCE H. HOWARD, recently Assistant General Manager of the St. Charles Car Company, has been appointed Secretary of the Safety Car Heating & Lighting Company, and will remove his residence to New York. Mr. Howard has done a great deal of hard and successful work while with the St. Charles Company.

OBITUARIES.

COLONEL CHARLES E. BLUNT, U. S. Engineers, died suddenly in Boston, July 10, aged 69 years. He was a native of New Hampshire, and graduated from West Point in the Class of 1846. During his 40 years' service in the Engineer Corps, he had a wide experience in charge of fortifications and river and harbor work on the Atlantic Coast and the great lakes. He was stationed for 15 years at Buffalo, N. Y., and was retired at his own request, in January, 1887.

W. K. MUIR, who died June 28, was for a number of years connected with the former Great Western Railway as Assistant General Superintendent. He was also for some time General Manager of the Detroit, Grand Haven & Milwaukee Railroad, and was afterward General Superintendent of the Michigan Central. He was born in Scotland in 1829, and after some service on Scotch and English railroads came to Canada in 1852 and was employed on the first section of the Great Western. Mr. Muir retired from the Michigan Central several years ago and has been since President of the Eureka Steel Works.

PROCEEDINGS OF SOCIETIES.

Roadmasters' Association of America.—Mr. J. H. K. Burgwin, Secretary, announces that the Annual Convention will be opened at Chattanooga, Tenn., on Tuesday, October 18 next. One meeting will be held in Chattanooga, and then the Association will adjourn to meeting for the business sessions at Atlanta, Ga., on the following morning.

American Institute of Mining Engineers.—The sixty-second meeting was held at the Hotel Champlain, near Plattsburgh, N. Y., beginning July 5. At the opening meeting Mr. F. S. Witherbee made an address on the Early Development of Iron Manufacture in the Champlain Region, where a large number of forges were in operation at a very early date. The President, Mr. John Birkinbine, then made an address on the Influence of Location on the Pig-Iron Industry, showing the various changes which have occurred from the first establishment of the industry in this country, and the causes which produced them, the chief among which were the proximity to market and supply of ore and fuel.

Memoirs of the late Dr. Hunt and of William P. Shinn were read. Dr. James Hall, State Geologist, exhibited the new geological map of New York.

On the second morning the members proceeded to Port Henry and thence to Crown Point and Mineville, inspecting the furnaces and mines at those places. In the evening a session was held at which several papers were read, including one by Dr. C. B. Dudley on Specifications for Iron and Steel.

On Thursday morning an excursion was made to the Chataugay Iron Mines and Lake Saranac, a stop being also made at Lyon Mountain.

The meeting was concluded by two business sessions, at which a number of papers were presented and some of them were discussed.

Mechanical Engineering Teachers' Association.—This Association was formed at a meeting held in Columbus, O., in June, 1891, the object being to secure by co-operation the best courses of study and the adoption of methods of instruction which may lead to the highest efficiency of mechanical engineering schools. A number of members have joined and others are expected to be present at the next meeting, which will be held in Rochester, N. Y., August 18. The place and time has been chosen in order to accommodate those members who wish to be present at the meeting of the American Association for the Advancement of Science.

The officers of the Association are: President, S. W. Robinson, Columbus, O.; First Vice-President, C. W. Scribner, Ames, Ia.; Second Vice-President, O. P. Hood, Manhattan, Kan.; Secretary, A. J. Wiechardt, South Bethlehem, Pa.; Treasurer, Storm Bull, Madison, Wis.

In the circular announcing the meeting the following points are suggested for study either for the presentation of papers or for general discussion:

"What subjects should be embraced in the course of Mechanical Engineering leading to graduation?

"Should any of them be optional?

"Should there be a post-graduate course, and if so in what should it consist?

"What should be the degrees for the above, and what the studies?

"Should there be included one or two modern foreign languages?

"What engineering studies should be included?

"What amount of mechanical laboratory should there be included?

"What subjects should be included in the mechanical labora-

tory; how much practice with the object of mechanical and manual training?

"How much fine mechanical practice, such as scraping of surface plates, grinding of standards, etc.?

"Should the construction of articles of manufacture be attempted at the school laboratory?

"What testing should be attempted?

"Should any part of the laboratory practice be classified as shop work, and so named unless articles are made for sale?

"Should anything be introduced that should be called 'shop work'?

"Should that portion of the laboratory embracing the manual element be classified as 'shop,' 'school shop,' 'work shop,' etc., or elementary mechanical laboratory?

"Should the more advanced portion, embracing testing of various kinds, be classified in such way as advanced mechanical laboratory, testing laboratory, etc.?

"It is further suggested that particular attention be given to the number of hours devoted to a subject, and the ground covered; the method of instruction—*i.e.*, whether by lecture, recitation or practice, separately or combined."

American Boiler Manufacturers' Association.—The Fifth Annual Convention was held in Buffalo, N. Y., beginning June 14, and was more largely attended than any previous convention. A number of important matters came up for consideration.

The Committee on Uniform Inspection Laws reported progress toward the adoption of a common standard for inspection in the different States, and also progress toward the adoption of a national law.

The Committee on Riveting and Calking reported progress, and was instructed to proceed with the tests which have been undertaken. These tests will include the bursting of boiler shells prepared in the same way as for actual service.

The Committee on Materials was continued, a carefully prepared report having been accidentally destroyed by the burning of the Chairman's office.

The Committee on Horse-Power presented a paper on the subject of the horse-power of boilers, and received instructions as to the final report, which is to be made next year.

The Committee on Statistics made a report explaining the difficulty in the way of obtaining figures and pointing out the errors of the Census report on the boiler business.

The Committee on Strikes made a report, which was discussed in executive session. This Committee was continued.

The following officers were elected for the ensuing year: President, Philip Rohan; Vice-Presidents, Richard Garstang, Charles Kroeschell and Michael Geary; Treasurer, Richard Hammond; Secretary, E. D. Meier.

It was decided to hold the next meeting in Chicago.

Railroad Telegraph Superintendents' Association.—The eleventh annual meeting was held in Denver, Col., beginning June 15. Four sessions were held, two on each day of the Convention, at which a number of papers were presented and discussed. Committees were appointed on Revision of the Constitution and to prepare a new form of service card.

Among the papers presented were one on Insulation, by T. A. Edison; on Galvanometers, by T. D. Lockwood; on the Government Time System, by Professor W. A. Gardner; on Block Signals, by J. B. Stewart, and on Electricity in Relation to Transportation, by Charles Selden.

It was resolved to hold the next meeting in Milwaukee. The officers elected were: President, L. B. Korty, Omaha; Vice-President, U. J. Fry, Milwaukee; Secretary and Treasurer, P. B. Drew, Chicago.

Master Mechanics' Association.—The officers elected at the Saratoga Convention are: President, John Hickey, St. Paul, Minn.; First Vice-President, William Garstang, Richmond, Va.; Second Vice-President, R. C. Blackall, Albany, N. Y.; Secretary, Angus Sinclair, New York; Treasurer, O. Stewart, Charlestown, Mass.

A summary of the Committee reports presented at the Convention will be found on another page.

Master Car-Builders' Association.—The officers elected at the Convention in Saratoga are: President, E. W. Grieves, Baltimore; First Vice-President, F. D. Casanave, Altoona, Pa.; Second Vice-President, J. S. Lentz, Packerton, Pa.; Third Vice-President, T. A. Bissell, Buffalo, N. Y.; Treasurer, G. W. Demarest, Baltimore; Secretary, John W. Cloud, Chicago; Executive Committee, J. T. Chamberlain, G. W. Rhodes, J. S. Leeds, and J. C. Barber.

THE Secretary announces that the revised Rules of Interchange, which will take effect September 1, are now ready for distribution, and will be furnished railroad companies at the same rate as heretofore.

The Air-Brake and Signal Instructions, as approved at the Saratoga Convention, will also be published in pamphlet form, the cover and size being so arranged as to make them readily distinguishable from the Rules of Interchange. The prices will be the same as for the Rules.

A CIRCULAR from Secretary J. W. Cloud has been issued, submitting two propositions to letter-ballot. The first is on the question of changing the Standard Wheel Guarantee under the heading of "Except in case of Wheels removed for the following causes," so that the first item shall read "Flat or comby by sliding," instead of "Flat by sliding," as now.

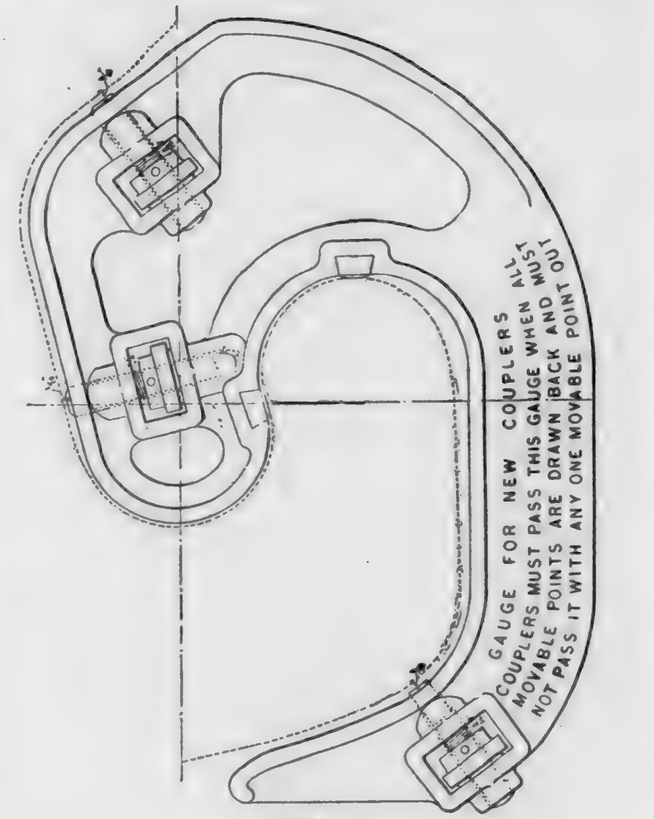


FIG. 1.

Dotted line is Standard Contour.

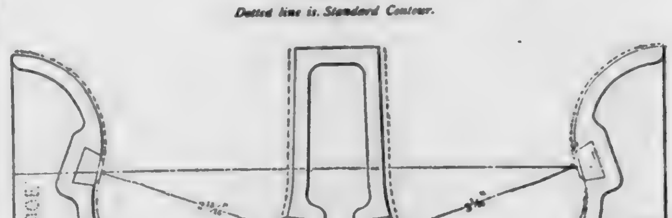


FIG. 2.

GAUGES FOR M. C. B. STANDARD COUPLER.

The second ballot is on the adoption of the coupler gauges shown in figs. 1 and 2 herewith, as standards of the Association.

The votes will be counted on August 31, and votes not received at the Secretary's office before that date will be excluded.

Engineers' Club of Philadelphia.—At the regular meeting, June 18, the Tellers reported the election of Messrs. George C. Thayer and William Elton Mott to Active Membership.

The resignations of Professor L. M. Haupt and Mr. Jesse Garrett were accepted.

Upon motion the Club appointed Mr. Joseph M. Wilson to aid the Committee of the American Society of Civil Engineers by the suggestion of suitable persons to furnish papers for the meeting of the World's Congress Auxiliary of the Chicago Exposition.

A paper by Captain Smith S. Leach, on the Improvement of the Mississippi River, was presented and read by the Secretary. Mr. Trautwine explained that this paper was written, by request, to more fully explain the method of fixing the banks and confining the floods of this river, which had been illustrated by a series of photographs presented some time since by one of the members of the Club.

A communication from Mr. Robert L. Holliday, describing a stone box culvert, built in 1832, south of Newcastle, upon the Delaware Division of the Philadelphia, Wilmington & Baltimore Railroad, was read, and a sample of 2-in. white pine plank, which formed part of its foundation and had been under water for 60 years, was exhibited in connection therewith. The wood showed an excellent state of preservation, and excited much interest.

A section of the first rail used by the Camden & Amboy Railroad was presented by Mr. Rufus Hill, Master Mechanic of the Pavonia Shops. It is believed to be from the first lot of rails made in this country, and was laid November 12, 1831, at Bordentown, N. J. Designed by Mr. R. L. Stevens.

Mr. Wilfred Lewis, upon request, briefly described the recent trip of the American Society of Mechanical Engineers to San Francisco.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held in Pittsburgh, June 21. Mr. Alfred E. Hunt in the chair; Mr. R. N. Clark, Secretary.

The paper for the evening was by Mr. W. Lucian Scaife, on Some Data on Rail Joints. In 1885 a paper was read before the Society by Mr. Max J. Becker on Why do Rail Joints Break? This paper caused so much interest that a committee was appointed consisting of Messrs. Thomas Rodd, Max J. Becker, W. H. Borntraeger, the late W. R. Jones, C. L. Strobel, W. L. Scaife, William Scherzer, James G. Dagron and Franz Engstrom. In order to obtain the benefit of the experience of railroad engineers a circular was prepared and sent to most of the railroad companies in the United States and Canada; it contained a list of 25 questions which were believed to cover the subject. In response to these and other circulars, answers were received from engineers, general managers, and superintendents of about 61,000 miles of railroad; many of them were accompanied with drawings of rails, splice-bars, road-beds, nut-locks, etc., and furnished much valuable information outside of the questions contained in the circulars. These were carefully tabulated by Mr. Engstrom at the time hey were received.

Messrs. Max J. Becker, F. Engstrom, Victor Weirman, E. B. Taylor and others joined in the discussion. The Committee by its request was relieved from further duty.

The Society adjourned to September 20.

At the regular meeting of the Chemical Section on June 28, Mr. R. B. Carnahan, Jr., read an interesting paper on Tin Plate Analysis. He described simple and rapid methods of determining tin, lead, iron, and manganese in tin and terne plate. He also spoke of the determination of tin in solder. His paper was discussed by Messrs. Williams, Camp, Handy and others.

Engineers' Club of Cincinnati.—The subject for discussion at the regular meeting held in June was that of a new water-supply for the city of Cincinnati, which was appropriate at this time on account of the election to be held soon to vote on an appropriation for the purpose, and the new water-works commission to be appointed.

Papers on the subject were prepared by Colonel Latham Anderson, G. Bouscaren, M. D. Burke, and John W. Hill, of Cincinnati, and by Edward Flad, of St. Louis, in addition to which Messrs. Hosea, Whinery, Baldwin, Harper, Ewing, Mathewson and Punshon took part in the discussion.

Several prominent citizens, not members of the Club, were present and were much interested in the proceedings.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, July 1. M. P. Boes and G. W. Sherwood were elected members; W. R. Phillips an associate member.

A committee was appointed to prepare a memorial of Andrew Fraser, lately murdered in Mexico.

A paper was read by Mr. Hugo P. Frear, entitled A Problem in Launching the Pacific Mail Steamer *Peru* at the Union Iron Works. The paper was illustrated by diagrams.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held at the Club-rooms, June 14. Mr. Irving Mason Wolverton was elected an Active Member. The discussion of the evening was on the annual address of the retiring President, Mr. Gobeille, on the subject of the Financial Status of the Engineer.

The regular meeting was held in the club rooms July 12. The committee appointed to take action on the death of John Whitelaw, ex-President of the Club and for many years Superintendent of the Cleveland Water Works, made their report. Wendell Phillips Brown was elected an active member.

The paper of the evening was read by Dr. C. S. Howe, of the Case School of Applied Science, and was a Mathematical Discussion of Some Census Reports, with Special Application to the Population of Cleveland, Past and Future.

Engineering Association of the South.—The regular June meeting was held at the Association headquarters in Nashville, Tenn., June 9. Vice-President James Geddes presiding.

After consideration it was decided to hold the regular meetings of the Association on the regular dates, the second Thursday evening of each month, and not to suspend during the summer, as heretofore.

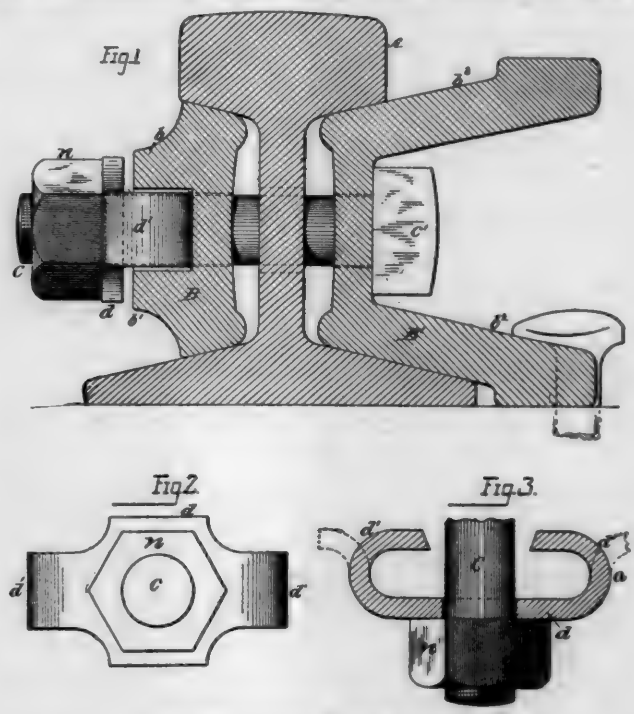
The paper of the evening—Notes on Mine Surveying—was read by Mr. Benjamin W. Robinson, Mining Engineer of the St. Bernard Coal Company of Earlington, Ky.

The regular July meeting was held in Nashville, July 14; Colonel H. M. Robert, U.S.A., presided.

W. W. Carson, of Knoxville, Tenn., then read a paper on the Mississippi River problem. He spoke briefly of the caving in of the banks of the Mississippi River by the acre; of the vast amount of silt borne by the stream while in flood; and of the heavy deposits which occur where the current is retarded.

NOTES AND NEWS.

A New Rail-Joint.—The accompanying drawing shows a rail-joint recently devised and patented by Mr. G. Bouscaren, of Cincinnati, the well-known engineer. Fig. 1 is a section of the joint; figs. 2 and 3 show the spring washer used in connection with it. In this joint Mr. Bouscaren seeks to avoid the imperfections of existing joints, as he explains in his patent,

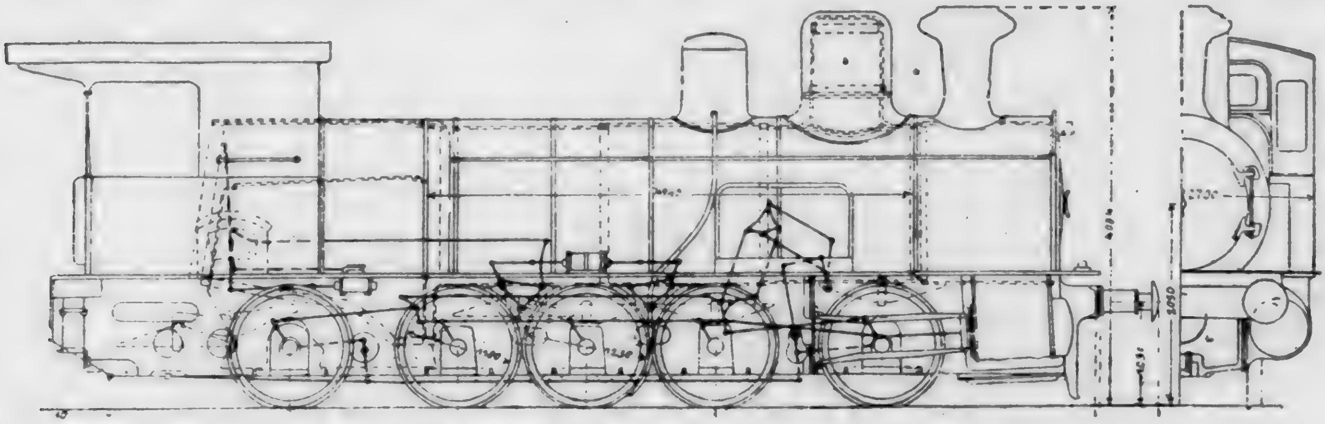


BOUSCAREN'S RAIL-JOINT.

"by employing splice-bars as deep as consistent with the clearance of the flange and tread of the wheels; and my invention consists in the channel form of cross-section of the bars, whereby the distribution of metal in the flanges of the bars is as far as possible removed from the neutral axis and thereby conducive to the greatest resistance; in giving the bars a symmetrical cross-section, whereby the bolt-holes are located on the neutral axis and their weakening effect reduced to a minimum; in the use of a non-rotatable spring-washer of great

power under the nut of each bolt, whose function is to maintain at all times a perfect bearing between the rails and splice-bars, and in providing for the non-rotation of the bolts, thereby assisting to preserve the proper relation of parts. The combination of all these features gives a joint of great strength and durability under both vertical and lateral stresses, which can be cheaply manufactured and easily maintained in the track."

Some Heavy German Locomotives.—Not long ago there were put in service on the Württemberg State Railroads some extremely powerful locomotives, which are used in freight service on the Göppingen-Gaislingen section, where there are continuous grades of 1 in 100, or 52.8 ft. per mile, and on the adjoining Gaislingen-Ulm section, where the ruling grade is 1 in 44, or 120 ft. per mile.



TEN-WHEEL LOCOMOTIVE, WÜRTEMBERG STATE RAILROADS.

These engines, which are decribed in a recent number of *Glaser's Annalen*, are carried on 10 wheels, all coupled, the connection of the two pairs at the outer ends being by the Klose system. The drivers are 48 3 in. in diameter, and the total wheel-base is 19.7 ft. The total length of the engine over all is 37 ft. The sketch given shows the general outline. The engines are compound, having one high-pressure cylinder placed inside, and two low-pressure cylinders outside; all three cylinders are the same size. They are so arranged that on the heavy grades steam from the boiler is admitted directly to the low-pressure cylinders, the locomotive then working as a three-cylinder simple engine.

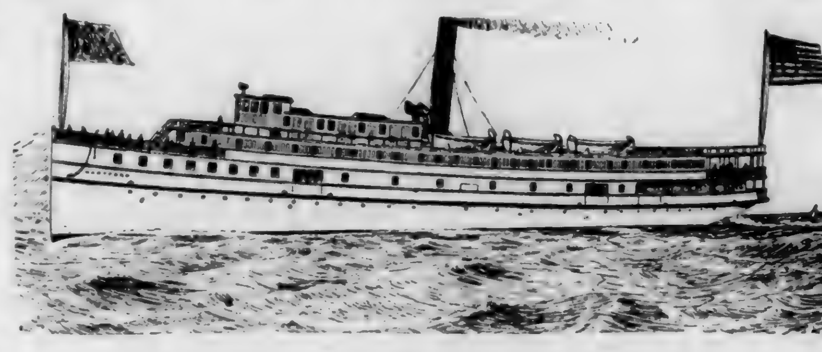
The arrangement of the wheels on the Klose system gives these engines sufficient flexibility to work over sharp curves, while the long wheel-base gives them sufficient stability to run at passenger-train speed, thus making them very useful machines. The object in designing them was to make an engine which could be used for all service, and would do the work which usually required two six-wheeled engines coupled. They are believed to be the heaviest and most powerful engines in use in Germany.

In ordinary service these engines take a train weighing 600 tons up the 1-per cent. grades and one of 300 tons on the 120-ft. grades. On trial trips they have taken trains of 700 tons and 350 tons respectively. They have worked so far very well, handling the trains on the mountain lines more economically and safely than when they were worked with two engines.

Color Photography.—In a lecture recently delivered before the Royal Institution in London, Mr. F. E. Ives described a new process of color photography. This is an invention utilizing comparatively old and familiar photographic processes. It was not a simple invention, but comprised several inventions by different men. By means of a compound camera front three photographic negatives of the object were made by simultaneous and equal exposure, from the same point of view, and upon the same sensitive plate. The photographic plate was sensitive to all colors of light, but by the introduction of light filters one of the negatives was made by such light rays only as excited the fundamental red sensation, and in due proportion another by light rays that excited the fundamental green sensation, and another by light rays that excited the fundamental blue-violet sensation. From this triple negative a triple lantern slide was made which, although it showed no color, contained such a graphic record of the natural colors that, in order to reproduce them to the eye, it was sufficient to superpose the three images, one with red light, one with green, and one with blue-violet. This was accomplished either in his new heliochromoscope—a device about the size of a hand stereoscope, and used in much the same way—or by projection with a special optical lantern, having three optical systems, with red, green and blue glasses. The three images, being exactly superposed, appeared as one only, in which the natural colors were exactly reproduced, together with the light and shade. Images of three ordinary photographs, exactly alike, if superposed in the same way through the same colored glasses, would show no color whatever. The process was as scientifically accurate for reproduction in color as ordinary photography was for reproductions in monochrome, but at present it could be carried out successfully only by a scientific expert employing the photospectrograph for testing the sensitive plates and adjusting the selective color screens. When such preliminary adjustments had been correctly made the process was almost as simple and trustworthy as the ordinary negative process. By a modification of the process, introducing further complication, color prints were made on glass or paper; but the comparative simplicity of the plan of superposing images commended it to scientists and was more convincing to the general public.

A New Sound Steamer.—The accompanying illustration, for which we are indebted to the *Seaboard*, shows a new steamer for Long Island Sound, of a class which is gradually replacing the side-wheel steamers which have for so many years been the prevailing type in the waters around New York.

The new steamer, which is named *Hartford*, has been lately completed by Neafie & Levy, in Philadelphia, for the route between New York and Hartford, Conn. She is an iron boat, 231 ft. long, 40 ft. beam and 13 ft. depth of hold. The passenger accommodations are excellent, the main saloon being on the upper deck and having 44 state-rooms. There is room for a large amount of freight on the lower deck. There is a full electric light plant, including a search-light on the pilot-house. The hull is divided by water-tight bulkheads into a number of compartments.



STEAMBOAT "HARTFORD," LONG ISLAND SOUND.

The *Hartford* is propelled by twin screws, each driven by an independent compound engine with cylinders 20 in. and 40 in. in diameter and 28 in. stroke. Steam is furnished by four tubular boilers 8 ft. diameter and 14 ft. long.

Although of comparatively light draft, as required for her route up the Connecticut River, she has shown very good speed, making 15 knots an hour in regular work.

THE RAILROAD AND

ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, SEPTEMBER, 1892.

ON another page will be found the first of a second series of articles on "Practical Railroad Information." Like the first series, this will be based on the results of many years' experience in the Testing Department of a large railroad ; but while the first dealt with results, this series will describe the methods used in testing. It will contain much that has never before been made public, and much valuable information.

THE plans for the new rapid transit line in New York are nearly finished, and the Commission will soon be ready to take the next step and offer the franchise for sale. It will then be seen whether any capitalists are willing to undertake the building of the line. Some doubt has been thrown over this by the cutting off of the most valuable part of the franchise—that for a line through the densely populated east side of the city and into the annexed district north of the Harlem River, which is growing more rapidly than any other part of the city.

IN this connection it may be noted that the New York Central & Hudson River Company has unaccountably neglected its opportunities of serving the annexed district. It has a line already built to the center of the city, and were proper facilities given, its Harlem Division might carry three times the business it now does. Under the present system the business which really belongs to it is being carried off by the Suburban Elevated and other lines, while the growth of the district is checked by the lack of transportation. A short-sighted policy like this is not to the credit of the company.

THE annual statement of the Sault Ste. Marie Canal for the year ending June 30 shows an enormous business. The number of vessels passing through the canal was 11,557, or 2,027 more than in the previous year, and a greater number than ever before. To pass these vessels required 5,615 lockages. They carried over 25,000 passengers and 10,107,622 tons of freight. The figures show that the average distance each ton of freight was carried was 820 miles, and the average rate was extremely low, being only 0.135 cent per ton-mile.

It may be noted that the total number of passages given above was made by 652 vessels—that is, each passed through the canal an average of 17½ times. Of these vessels 595 belonged to the United States and 57 to Canada. The largest cargo taken through was by the steamer *E. C. Pope*, and consisted of 103,000 bushels of wheat.

The great lock at Sault Ste. Marie now enjoys the distinction of passing a greater tonnage than any other canal lock in the world, the business far exceeding that of the Suez Canal.

THE bids for the new Croton Dam, the plans for which were recently described, were all rejected by the New York Department of Public Works ; and new bids are to be advertised for.

THE great drawback to the Southern iron trade heretofore has been that the pig iron produced in the Alabama and other districts has had too large a proportion of silicon and phosphorus to be used in making Bessemer steel. It is now stated that a process recently invented by Benjamin Talbot, of Chattanooga, has been successful in removing the silicon, and it is claimed that by the use of this method steel of a good quality can be produced at a very moderate cost. The process is to have a thorough practical test on a large scale. If it succeeds, it will be a matter of very great importance to the Southern ironmakers—and to their Pennsylvania competitors as well.

IT is stated that considerable changes have been made in the armor plans for some of the new ships. The turrets for the *New York* are to have straight vertical instead of inclined sides, and in some of the other ships the form of the armor will be a series of straight lines, instead of corresponding to the lines of the ship.

It is said that these changes are made to hasten construction by avoiding the difficulties incurred in bending heavy plates to the exact shapes. It is unfortunate that this has appeared to be necessary, and it is to be hoped that as little of this kind of work as possible will be done.

THE effort to concentrate the road exhibit at Chicago has not been abandoned, and is to be continued by Colonel Pope and others as long as there is any possibility of success. It will certainly be a mistake if the effect of the exhibit of machinery and appliances of such an important class is weakened by scattering it about through several different buildings. It should be kept together so that those interested in the subject could study it carefully, and the attention of many others, who ought to be interested, may be easily drawn to it. It is somewhat late now to make a new classification, but it ought to be done if there is any possible way to do it.

THE most valuable through train which ever crossed the continent was one which arrived in New York on the morning of August 9, carrying $20,000,000 in gold sent from the sub-treasury in San Francisco to that in New York. It consisted of four baggage cars carrying the gold and a sleeping car for the guards who accompanied it. It was in charge of officials of the Post-Office Department, and was well guarded throughout its journey ; but

no attempt was made to interfere with the safe transit of the treasure.

The train made an exceptionally fast run, leaving San Francisco at 6.30 P.M. on August 4, and reaching New York at 10.46 A.M. on August 9; the total time was thus 4 days, 13 hours, 16 minutes, or less than an hour more than the time made by the fastest continuous through train on record.

Two companies at least—the Pennsylvania Company and the Illinois Central—are making provision for the short travel to the Chicago Exposition next year by building what may be called temporary passenger cars—that is, they are cars built up on freight-car platforms and sills, with light sides and a freight-car roof and framing. They will be provided with comfortable seats and will answer for short excursion travel, and after the extra demand is over they can be converted into freight cars.

WHAT is the finest and most expensive passenger station was a question lately discussed by some men of experience, according to the Philadelphia *Record*. The handsomest architecturally was said to be that of the Great Indian Peninsular line at Bombay, which took ten years to build. The most commodious was the new union station at Frankfürt-am-Main, Germany, while the most costly were two of the terminal stations in London and the North British station in Edinburgh, which were made so by the enormous prices paid for the property they occupy.

THE Chief Engineer of the Navy has prepared recently a new system of examinations for promotion in the Engineer Corps of the Navy, which is said to be very comprehensive and thorough. Candidates for promotion will have to be thoroughly versed in the theory and practice of the modern marine engine and boiler, and in methods of propulsion of vessels, while some knowledge of electric-lighting plants and their management will also be necessary.

THE LABOR QUESTION.

DOUBTLESS many of those who read the above title will feel the same sense of weariness in doing so that we do in writing it. For weeks the daily papers have been full of accounts of strikes, attended with violence and bloodshed, and at times it seems as though a civil war was impending. It is impossible for a fair-minded man to say of either side that it is altogether right and the other altogether wrong. Of course, when murder and arson are roaming hand in hand over the country, all law-abiding people will agree that the first duty is to suppress such crime, and enforce the laws and re-establish security to life and property, and settle the disputes afterward, if that is possible. It has been said by some one that it is a mistake to assume that the function of law and government is to administer justice; its first object is to stop contention and preserve order, and this takes precedence over the administration of justice. Therefore, the first duty of law-abiding people in the community is to suppress violence at any cost of injustice to labor—men or employers—or, if need be, any sacrifice of life. Even in the midst of war, though, we may speak and think of the means of attaining peace.

With reference to the causes of the switchmen's strike at Buffalo, the daily papers report that "Grand Master Workman" Sweeney made the following statement:

> Certainly the men have done everything that a man with an ounce of self-respect could do to avoid forcing the issues to a strike. The Lehigh Valley men first asked for a reform in certain places on June 11 last. The companies' officers refused to listen to anything. They have the idea that they can drive the men and frighten them into submission, but they are mistaken. Switchmen cannot be driven. There is no question of the justice of their demands. The public, the newspapers, even the companies, admit that a man should be paid for all the hours he works, and should receive a decent, respectful hearing if he finds that he is being abused. These men ask that they be paid by the hour, and that they be given time to eat their dinner. Not unreasonable demands, are they?
>
> They also ask that when their committees go to the officers of the road to call the attention of the officers to abuses in a respectful manner the committees be accorded common civility. The committee that waited on Superintendent Burrows of the New York Central were insulted by him, and were at once discharged. They reported to the organization, and as a result of Burrows' brutal, overbearing conduct the men are out. Nobody to blame but Burrows.

Now, we have not the slightest means of knowing how far or how near this statement is to or from the exact facts, or what mitigating circumstances there may be which, if known, would modify these charges. Some allowance ought doubtless to be made for the heat of the weather and of Mr. Sweeney's brain.

In another daily paper the same official is reported as saying that Mr. McLeod, the President of the Reading system, "declined to even see the committee of the organization which went to interview him," and that

> The committee that called on the New York Central officials were discharged in a body by Mr. Rossiter, the Assistant Superintendent of the Western Division, merely for making their grievances known. They were subsequently reinstated, however.
>
> They were subsequently discharged peremptorily by Yardmaster Maloney. A second committee went to the company with the same grievance, and expecting to meet with the same fate. Mr. Rossiter told them the other committee had been discharged because they lied to him.

The difficulty of getting at facts in the present excited state of the minds of the parties on both sides of this dispute is apparent when at the end of the same article it is reported that Mr. Voorhees, the General Superintendent of the New York Central Railroad, denied all knowledge of the statement made by Mr. Sweeney that the members of the Committee of Grievances had been discharged for coming before him. He said they had been suspended for leaving their work without permission, and that the suspension only lasted five days.

The exact measure of truth in these statements is not important, however, for our present purpose, which is to call attention to a lecture delivered by M. Julien Weiler, which is reprinted on another page, and which gives some experience and suggestions with reference to this question of the treatment and recognition of committees of the men. In other words, the question propounded is whether it is wise to refuse to receive and hear committees appointed by the unions of the men to represent their interests? There can be no doubt that it gives the men a decided advantage to be thus represented, and, to quote from Mr. Thornton's excellent treatise on labor, "On what pretence are they to be denied the privilege of having their cause argued for them by attorney." As a consequence, as pointed out by M. Julien Weiler, of the danger of dismissal, the best men are indisposed to serve on committees. The blatherskites, then, take their places, and the difficulty of rational negotiation is much increased. In some cases men to serve on committees are selected from

trades outside of the one which has a grievance to present, in order that the committee may not incur the danger of dismissal by such service. Surely it cannot be a wholesome relation between employers and men when the most clear-headed, the most industrious, intelligent, and conservative are prevented from representing their own interests and those of their associates to their employers. "To him that worketh," says St. Paul, "reward is reckoned, not of grace, but of debt." Some railroad officials seem to be slow in taking this apostolic view.

In the present condition of lawlessness the paramount question is, of course, its suppression ; but under a reign of law the complete recognition of the right of men to be represented by committees of their own number would, it is believed, do more than any other step to prevent misunderstandings and contentions between men and their employers.

COMPOUND LOCOMOTIVES.

ANY one who has served on juries often must have noticed that during the effort to come to an agreement, in cases concerning which there is any marked difference of opinion, the conduct of nearly all juries is very nearly alike. On having a case submitted for a verdict, a majority of the jurors are at first reticent and indisposed to reveal their opinions—if they have any—while one or two are apt to announce their conclusions decisively. There is then a little cautious argument, which gradually grows into warm discussion. A vote will likely be taken to see how the members stand. After the vote, if opinions differ, discussion will be renewed, mildly at first, but increasing in warmth, until one half will probably be shouting. Some are then reduced to silence, and finally the loud administrators of justice grow weary, and boisterous argument is succeeded with tranquility, and then rational discussion may again be possible and some jurors made amenable to sound reason.

The compound locomotive discussion seems to have gone through most of these different stages and to have reached the period of tranquility, so that we may now expect enlightened discussion, and a fair consideration of the evidence which has been submitted.

A seeker for information concerning the relative merits of compound and non-compound locomotives, after examining the subject is apt, too, to find himself in the same confused state of mind that jurors are often in before argument on their case has been heard, and the eloquence of the advocates of this system of locomotives is apt to leave the inquirer with a similar bias to that which the administrators of justice are apt to have after the counsel for the plaintiff has been heard. Probably many of those who attended the Master Mechanics' Convention last June, after hearing the report and the discussion on the subject of this article, were also left in the perplexed state of mind that jurors are sometimes in after counsel for the defense has knocked down the arguments and thrown doubt on the evidence of the other side. Unfortunately thus far no competent judge has summed up the case of compound *versus* simple locomotives, so that all of us who are interested in the subject are compelled to browse among the rather sparse facts and evidence which is accessible, and draw such conclusions as we can, or keep our minds blank until such time as the light will be clearer.

To most sincere inquirers for information the report of the Committee of the Master Mechanics' Association on this subject, we think, must have been disappointing. Its inconclusiveness leaves the question very nearly where it was before they made their elaborate tests. The main questions, after all, are the amount of saving of fuel which can be effected by the compound system, and the efficiency of the engines—and by the latter we mean the amount of work which can be done by them—or, in other words, the number of cars hauled per train and the number of miles run per year.

It seems as though decisive testimony could be obtained with reference to these important points with much less elaborate tests than the Committee undertook. In fact, the Committee seems to have been almost overwhelmed by the excessive elaborations of their own experiments. The real questions which a railroad manager wants answered in order to determine whether it would be best to get compound or simple engines for the traffic of his road are, first, whether the compounds will haul his trains and do it regularly without an excessive amount of failures, and, next, whether the saving in fuel will be materially greater than the addition to the cost of repairs and interest on first cost.

Now on nearly all roads there are a number of trains which run with a tolerable degree of regularity, and with a uniform number of cars. At any rate, with the co-operation of the transportation department the number of cars can usually be regulated during a period long enough to make conclusive tests. Now supposing that on such a road a run of this kind, of from 100 to 150 miles, with, say a freight train, was selected, on which the number of cars to be hauled by the experimental train could be regulated within certain limits. The question of most importance to the manager would be, How much coal will be burned by a compound engine and how much by a simple engine of like size and weight and under like conditions ? The question is not whether a heavy compound locomotive will haul more cars or do it with less fuel than a light simple machine, but it is, which of two machines of the same weight and with the same steam pressure will do the work most economically. Until this is decided indicators, dynamometers, pyrometers, calorimeters, etc., might be ignored and their use reserved to investigate the causes of the good or bad results obtained by the simpler tests. Having two such engines, let one of them begin by hauling a moderate-sized train on a given run, and appoint some careful and reliable person—two would be better to check off each other—to weigh the coal taken on the tender and that left on it at the end of the run. Also arrange to have the cars of each train weighed by an experienced weigh-master. Let the simple engine take such a train one day and the compound the same kind of a train, as near as possible, and on the same run the next. Gradually increase the loads hauled, until each engine has reached its limit of capacity. If the results of such a series of tests was made by careful engineers and firemen on each engine for, say, two weeks, and were then repeated for two weeks more and the men exchanged from the one engine to the other, the tests would show with a very considerable amount of conclusiveness which kind of locomotive was able to do the kind of work in which it was employed most economically, at least so far as fuel consumption and efficiency are concerned. After such facts were established it would be time to use indicators, pyrometers, calorimeters, dynamometers, and other scientific instru-

ments to ascertain the causes which led to the results thus obtained.

Of course in making such tests, in order to arrive at any reliable conclusions, both engines should have fair play. It is to be presumed that the inventors, builders, and advocates of the compound system will do all in their power to obtain the very best results from it, and it is of course right that they should; but there is reason for believing that in some of the comparative tests which have been made the simple engines have had no equally intelligent and zealous advocates and friends.

The performance of new compound locomotives with every appliance that ingenuity, skill, and experience can suggest have been worked in competition with old simple engines which were friendless. After all has been said in favor of the compound, it still remains that the simple system has some advantages over the compound, as is indicated by their respective names. Ever since machinery has been used *simplicity* has been regarded as an advantage, and it is only when some very important advantage can be obtained by complexity that it becomes economical.

All the systems of compound locomotives thus far proposed involve a material addition to their weight. To the extent to which the weight is increased by compounding it is a disadvantage, and it is no more than fair that the simple system, in a comparative test, should have the advantage which might be derived from a similar increase in weight. If the boiler of a simple engine can be made larger to the extent of several thousand pounds of weight, it will have very much the same influence on its economy that the diminished demand for steam has on the compound boiler. This is an advantage which may legitimately be claimed for the simple system.

All compound locomotives must have either larger cylinders or more of them, and some other additional parts which will be certain to cost more to maintain than the smaller and simpler mechanism of the old-fashioned machines. How much or how little this increase will be probably only a considerable number of years' experience will tell.

There is, too, a perpetual amount which must be charged to the compound system, on account of the increased cost of the engines. This has been roughly estimated at about $750. It is probably more in some cases and less in others. Ten per cent. should be allowed on this annually for interest and renewals, which gives a yearly charge of $75 against the compound engines.

In their favor it must of course be admitted that there is a saving in fuel. How much is this? is the question which all who are interested in locomotive performance have been eagerly asking. The Master Mechanics' Committee give as the result of their test a final figure of 7.6 per cent., but add that the series of tests which represent most nearly the *average* monthly or yearly economy to be derived from compound engines show a saving of 16.9 per cent. of coal and 14.1 per cent. of water. These taken in connection with others, but notably the results of three months' work on the Northern Railroad of France —a report of which was published in the JOURNAL of last month—and which showed an economy of 14.45 per cent., lead to the inference that it would be safe to accept 15 per cent. as the average saving in fuel by the compound system of locomotives. It is not certain though that this might not be reduced if the simple engine was given all the advantages which might rightly be claimed for it.

On this basis Mr. Leeds, Superintendent of Machinery of the Louisville & Nashville road, during the discussion at the recent meeting of the Master Mechanics' Association, summed up the argument for and against compound engines for his line very concisely by saying that his engines burn about $1,800 worth of coal per year. A saving of 15 per cent. on this amounts to $270. Deducting the interest and maintenance charge of $75 leaves a net economy of $195. If we represent the unknown extra cost of repairs for compound engines at x, then we would have $\$195 - x =$ the net saving for the compound engines on that line. On the Louisville & Nashville line, however, coal costs somewhat less than $1 per ton. If the calculation was made for a line whose coal costs, say, $5 per ton, then the net saving would be $= \$1,275 - x$, or on the Central Pacific and other lines, where it costs over $10, the saving would be $= \$2,625 - x$. It may and probably will appear then that while the compound system may be economical on roads on which coal is dear, it may not be on those on which fuel is cheap.

The question whether compound locomotives will do as much work—that is, pull as heavy trains and run as many miles, on an average, in a year, is, however, a very important one. A horse which is often sick and thus unfitted for work when he is needed is a much less valuable beast than one which can work every day. Continuous and unremitting capacity for doing work is of much greater importance in locomotives than in horses. When a road is crowded with traffic and with an insufficient equipment it is of the utmost importance that its engines should be able to work without ceasing. The machine which will turn up ready for service at all times is the one which will be preferred, even though it is not as economical in fuel as some others, but which have delicate constitutions.

Then, too, the loads which can be hauled is a very important matter, as a very great saving results from an increase of train loads when there is a heavy traffic. This has been explained very often, but a few figures to show it anew will not be amiss here.

On the Lake Shore road last year the cost of fuel for locomotives amounted to 4.76 per cent. of the earnings. The cost of locomotive service was 6.51 per cent., and of freight-train service 3.17, or a total for both kinds of service of 9.68. An increase of train loads would add little or nothing to this latter item of expense. An increase of 10 per cent. in the train loads would therefore effect a saving of 0.968 per cent. If the fuel consumed was increased in like proportion it would amount to only 0.317, so that there would be a net saving of .651 per cent. It will be seen then that it would be economical to increase the weight of the trains, even though the fuel consumed was increased in even a greater proportion than the loads hauled. It is therefore of the utmost importance to know whether compound engines can haul as heavy trains as simple engines of the same weight, and therefore it is to be hoped that the able Committee which has been appointed to report on this subject next year will take some steps to throw light on this branch of the subject.

There is one kind of service in which undoubtedly compound locomotives may be expected to show a much greater economy of fuel than 15 per cent. We refer to service on heavy and long grades. For pushing engines the compound system ought to have very much greater advantages than for ordinary service.

RAILROAD STATISTICS.

At different times reference has been made to the methods by which railroad statistics are collected, and the difficulty of obtaining general figures in relation to the roads of the country. The Interstate Commerce Commission has undertaken to remedy this in part, and the report of its Statistician presents some valuable figures. The recent publication of *Poor's Manual* gives us, according to the usual custom of its publishers, an Introduction containing figures for a year later than those given in the Interstate report. The statements given in the *Manual* cover very nearly all the railroads in the country; the year is not uniform, different companies closing their fiscal years at different periods, but the totals given must approximate very nearly to correctness.

According to the *Manual* there was, at the close of 1891, a total of 170,601 miles of railroad in the United States, being an increase of 3,898 miles during the year. The mileage of the roads reporting their earnings, etc., was 164,262 miles, and on these lines there were in use 34,022 locomotives; 24,497 passenger and 7,368 baggage, mail and express cars; and 1,110,304 freight cars.

This property was represented by $4,809,176,651 capital stock; $5,235,295,074 funded debt; and $345,362,503 other debt. The last item, perhaps, does not exactly represent the real debt, as a large part of it consists of balances of accounts and similar matters.

The result of the operations of these roads was:

	1891.	1890.
Gross traffic earnings	$1,138,024,459	$1,097,847,428
Working expenses	781,814,579	750,926,110
Net traffic earnings	$356,209,880	$346,921,318
Interest paid	231,259,810	226,799,682
Dividends paid	90,719,757	85,075,705

The average interest paid, including all debt, was 4.10 per cent., and the average dividend on stock was 1.85 per cent.

The average mile of road earned last year $6,926 gross and $2,168 net. Of the total earnings passenger traffic contributed 25 84 per cent., freight 67 and other traffic 7.16 per cent. The average passenger train earned 90.7 cents and the average freight train 152.8 cents per train mile.

The total traffic reported for the year was:

Passenger train mileage	320,712,013
Freight train mileage	493,541,969
Mixed train mileage	16,948,394
Total revenue train mileage	831,202,376
Passengers carried	556,015,802
Passenger—mileage	13,316,925,239
Tons freight moved	704,398,609
Tons freight moved one mile	81,210,154,523

From this it would appear that the average passenger journey was 23.95 miles, and the average freight haul was 115.29 miles. For the first time in a number of years there was a slight increase in the average rates, which for three years past have been:

	1891.	1890.	1889.
Rate per passenger-mile	2.184 cts.	2.174 cts.	2.169 cts.
Rate per ton-mile	0.929 "	0.927 "	0.970 "

The figures indicate that the year was, on the whole, a fairly prosperous one for the railroads.

NEW PUBLICATIONS.

The Memphis Bridge—A Correction.

In our issue for July it was stated that Mr. George S. Morison, Chief Engineer of the Memphis Bridge, had issued an "album containing a number of sheets showing the general plan and much of the detailed work of the different spans of the bridge." We are requested by Mr. Morison to say that what we spoke of as an album was merely a set of the lithographic plans stitched up by themselves, these being taken from some of the plans which were made for use during construction, and were left over on the completion of the bridge. As he has had various inquiries asking where the album could be obtained, he has requested us to say that none was published.

Rare and Useful Information for Travelers, Mechanics and Railroad Men. Compiled by T. J. Nicholl, C. E. Chicago, Ill.; Danks & Company.

This is a little book of 72 pages and of size to be carried in the pocket, which contains a quantity of miscellaneous information on all sorts of subjects, railroad statistics, accidents, business law, speed of trains and a variety of other things, with a number of tables thrown in apparently to fill out the size of the book. Like most books of the kind it has something in it which is useful, but the tables can nearly all be found in any standard handbook, and it is somewhat difficult to understand the plan or principle upon which the book has been put together. A traveler, however, may find it handy.

The Log of the "Savannah." By J. Elfreth Watkins, Curator of the Section of Transportation of the United States National Museum. Washington; published by the Smithsonian Institution.

This is a reprint of the log of the *Savannah*, which was the first steamship to cross the Atlantic, and it is accompanied by a quantity of information in relation to the steamer, her construction and her cruise across the ocean. It is illustrated by several drawings and photographs. Mr. Watkins has done a service in thus preserving and putting into shape an authentic record, with the evidence connected with this noted voyage, in an accessible form.

Venezuela. *Bulletin No.* 34. Washington; issued by the Bureau of American Republics, W. E. Curtis, Director.

This is another one of the very useful and convenient monographs on the different South American countries, which have been from time to time issued by the Bureau of the American Republics in pursuance of its general plan for promoting the knowledge of those countries and intercourse with them. It is arranged on the same plan as the others, to which reference has heretofore been made, and has some excellent illustrations. Venezuela is a country of great natural resources, but is even less known in the United States than others of its sister republics, and the present volume will be of service.

The History of the Band-Saw. By W. Samuel Worssam, Engineer. London, England; printed for the Author.

Histories of special tools are not common, though in many cases they might be made interesting. Indeed, Mr. Worssam says in his preface:

> No previous account has appeared of the origin of the band-saw and of the progress and development it has made up to the present day. This work is the outcome of my experience, dating from the practical introduction of this interesting type of saw into this country, and of a personal knowledge of several of the inventors who are referred to.

The book includes a historical account of the first introduction and subsequent progress of the band-saw; descriptions of the machines devised for its use for various purposes; an account of its manufacture and of the various methods of using it. While Mr. Worssam is, of course, most familiar with English practice, he does not neglect that of other countries, especially of the United States, where wood-working machinery has had

its greatest development. While this little book is chiefly interesting to wood-workers, it is readable for any one who takes an interest in industrial progress.

COMMERCIAL INFORMATION CONCERNING THE AMERICAN REPUBLICS AND COLONIES. 1891. Washington; Bureau of the American Republics.

This is Bulletin No. 41 of the Bureau of the American Republics, and contains a large amount of recent information concerning changes in tariffs, shipping lines, mails and similar matters, besides late statistics of imports and exports, in the Argentine Republic, Colombia, Venezuela, Mexico and other countries. It is issued in pursuance of the general plan of the Bureau, to disseminate commercial information as widely as possible and to promote commercial intercourse between this and the other American countries.

RULES AND INSTRUCTIONS FOR THE GOVERNMENT OF EMPLOYÉS OF THE DEPARTMENT OF MAINTENANCE OF WAY AND OF BRIDGES AND BUILDINGS ADOPTED BY THE SOUTHERN PACIFIC COMPANY, ATLANTIC SYSTEM AND ITS CONTROLLED LINES. J. Kruitschnitt, General Manager. Houston, Tex.; published by the Company.

In this little book, which is issued for the information of its employés, the Southern Pacific Company gives a well-considered and carefully prepared set of rules for the government of the men employed in its track and bridge work. The rules have apparently been carefully revised to meet the demands of practice, and are generally expressed in a clear and direct way. In order to make them clearer still, they are accompanied by a number of plates showing the standard sections of road-bed, the standard rail-joints, frogs, switches, etc., adopted by the Company.

A full criticism would be impossible without taking up the rules one by one, but in a general way it may be said that they seem to fill the requirements of such a system of orders in a very satisfactory way. It is of great importance that rules for the government of railroad employés should be fully enforced. It is also of importance that they should be such as the employés can clearly understand, and that they do not include any that are difficult or impossible to be carried out. Requirements that cannot be enforced tend to bring the whole system into contempt and should not be allowed to exist. A certain degree of flexibility is always necessary, but this can well and properly be provided for in the rules themselves.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING. By A. M. Wellington, W. B. D. Penneman and Charles W. Baker. New York; The *Engineering News* Publishing Company.

This is a book of some 300 pages and 77 illustrations, and is a reprint of a series of papers published in *Engineering News*, which were intended to be an investigation into the comparative cost, safety, light-giving power and general advantages of oil lamps, compressed gas, gasoline carburetters and electric lighting for the illumination of passenger cars. The investigation has apparently been made with considerable care, and with the desire to be as impartial as possible as to the merits of different systems. The book includes descriptions of different systems of lighting; an investigation into the comparative photometric value of different lights; the comparative cost of plants and the comparative safety of different systems in cases of accident. It is perhaps the first attempt at a systematic consideration of the subject, and is really worthy of reading and consideration by railroad managers who have the decision of lighting questions.

The small size of the book, adopted for some unknown reason, is open to the objection that nearly all the plates and some of the tables have had to be put upon folding insets, which are always a nuisance to a reader. Most of the illustrations are good, but a larger page would have allowed them to come in their proper place on the pages and would have been a very great improvement.

MANUAL OF THE RAILROADS OF THE UNITED STATES FOR 1892. By Henry V. Poor. New York; H. V. & H. W. Poor.

But little that is new can be said of this volume, which is the 25th annual number of the well-known *Poor's Manual*, which many years ago became a standard book with all who are interested in railroads. No change has been made in its form beyond the necessary increase in size which comes from year to year. It is the only work of the kind which we have, and upon it investors and others must rely absolutely for information. Of course errors will creep in occasionally, but we believe that very great pains are taken to make the book as correct as possible, and its thoroughness and reliability are its great merits.

Some reference to the introduction to the *Manual* will be found on another page.

DYNAMOMETERS AND THE MEASUREMENT OF POWER. *A Treatise on the Construction and Application of Dynamometers; with a Description of the Methods and Apparatus Employed in Measuring Water Power.* By John J. Flather, Ph.B., M.M.E., New York: John Wiley & Sons.

The title of this book is sufficiently descriptive to give a general idea of its character. It contains six chapters on the Determination of Driving Power; Friction Brakes; Absorption-Dynamometers; Transmission-Dynamometers; Power required to Drive Lathes, and the Measurement of Water Power. It contains 77 illustrations, mostly very neat outline engravings made by the wax process. It contains, however, a few execrable "half-tone" engravings, such as figs. 25 and 39. Such cuts as these often make one regret that the half-tone process was ever invented.

The book consists very largely of excellent descriptions of the various kinds of dynamometers which have been used by different experimenters. These are admirably clear, although the professional tendency to rush into mathematics unnecessarily often, it is thought, manifests itself all the way through the book. To illustrate what we mean, on page 3 it is said that "for a general rule, in ordinary machine work we may take roughly 1 H.P. as sufficient to drive machine tools necessary to keep ten men at work."

It would seem as though this statement was as clear as it is possible to make it. By way of explanation, however, it is added:

"Expressed algebraically, this rule of thumb would be

$$\frac{N}{10} = H.P.,$$

when N equals the number of men employed; or, if we let $10 = C$, a constant, we have

$$\frac{N}{H.P.} = C."$$

Now it is submitted that the explanation is harder to understand than the original proposition. If the author had a psychological dynamometer and could measure the amount of cerebral energy which the reader must expend to understand his first proposition, and that exerted in following the mathematical elucidation, we feel sure that more units of phosphorus would be consumed in the latter exercise than in the former.

The book, however, is good in so many ways, so conveniently arranged and so clearly written as to deserve very high com-

mendation, and it is destined to become a standard of reference on the subjects to which it relates.

The printing and mechanical work is generally very good. It has one fault, however, very common in American books. The sheets are tightly stitched together, so that it will not open readily. To add to the discomfort in reading it, the margin is comparatively narrow, particularly the inside one. A quarter of an inch more margin on the inside would have added greatly to the comfort of the reader.

STREET RAILWAYS; THEIR CONSTRUCTION, OPERATION AND MAINTENANCE. A PRACTICAL HANDBOOK FOR STREET RAILWAY MEN. By C. B. Fairchild. New York; the Street Railway Publishing Company. Price, $4.

There have been treatises on street railroads or tramways, but none recently, and this class of roads has received so rapid a development, both in extent and methods of operation, within a few years past that a new treatise had become a necessity. Mr. Fairchild has undertaken to fill this vacancy, and has done it with a very considerable degree of success. In his preface he modestly disclaims any intention of making a complete or exhaustive work, but says that he has desired only to present in convenient form as many facts as possible bearing upon the street railroad industry, and to embody and present the results of experience brought as closely as possible up to date. A considerable part of the book has been published in serial form in the *Street Railway Journal*, but it has been revised in bringing it into book form. The extent of the subject can be best seen by the titles of the chapters, which are on Electric Traction; Cable Traction; Horse Traction; Steam, Air and Gas Motors; Inclined Planes; Rack-Rail Inclines; Elevated Roads; Car Building; Track Construction; Discipline and Rules; Franchises, Stocks and Bonds; Book-keeping and Accounts; Leading Types of Cars and Auxiliary Appliances. The great development of electric traction is very well treated and much space is given to electric appliances, but the cable road and other systems are not neglected. The chapters on Rules and on Operating are of a practical kind, and the author has given accounts of the best methods of management and those which have been approved in practice.

Upon the whole Mr. Fairchild has made a very good book, and one which will meet a decided want. It is very fully illustrated, although exception might be taken to the quality of some of the engravings. This is a minor fault, however, and it is better to have abundant illustration in a book of this kind, since the engravings help very much to an understanding of the text in description of machinery and appliances.

The book has a large-sized page, permitting the use of large engravings without the use of folding insets, which is an excellent feature. It can be recommended to all who are interested in street railroads and their methods.

ELEMENTS OF MACHINE DESIGN. *Notes and Plates for the Use of Students in Lehigh University.* By J. F. Klein, Professor of Mechanical Engineering. Second and Revised Edition, 1892. Bethlehem, Pa.; the Moravian Publishing House.

This is a nicely edited work, printed in large type on good paper, and illustrated with large folding plates. Its sphere of usefulness, however, appears to be limited to the use of the students at Lehigh University, as is stated in the title-page, and outside of that we find little in the work, as a whole, to recommend it for general reference.

Probably the students have a general course of study into which this work would admirably fit, but most of its chapters do not go deep enough into the subject-matter for the use of the engineer in his office, unless he be particularly well posted; and, if this is the case, then he would probably not have need for this particular work.

It belongs to that class of literature which abounds in the library of the mechanical engineer, and which is particularly dangerous from the fact that the work is not complete in itself; at least, that is true of nearly all its chapters. In working up any design this book would only assist one who had other works of reference, except in the few particulars of small dimensions, and if the book were limited to this use alone it could be made about one-third its size, and therefore much handier to use and easier to refer to.

The work appears to have been carefully compiled, and is as free from typographical errors as any book of this kind can be. Most of the illustrations explain themselves, but fig. 9, page 10, is difficult to understand from the text, and should have been accompanied by a drawing in plan. The subject of boiler thicknesses for strength is touched upon, but is left incomplete. The thickness of flues to withstand collapsing pressure is also studied, but the formula given is too complicated for practical use, and a much simpler one is always adopted.

In fact, if the work is to be useful as an assistant to the designing engineer these approximate formulas should always be given, as they will probably always be used in preference to any that may be more exact, but which are difficult to apply. Again, a chapter on riveting is given at some length, but to study the subject at all one must refer to other books. The proportions for rivets appear good as far as they go, but they do not go far enough. For instance, in boiler work rivets are selected more with reference to a tight joint, and when this is accomplished the rivets will be large enough. Therefore it seems to us that a table giving the average proportions of rivets as used to-day for different thicknesses of plate would have been much better than the discussion as published.

Again, under fastenings for boiler-heads it would have been well to have called attention to the fact that the styles, as represented in fig. 4 and fig. 6, are best adapted for machine riveting, and that is the chief reason why they are so largely used. It would have been well also to have stated the advantages and disadvantages of the conical and snap-shaped rivet heads, as long as the subject is touched upon at all.

The chapters on Gears and Gearing contain some good information, especially on the advantages to be derived from using involute teeth, but we think it would be difficult to design teeth for a given wheel from this work alone; and yet the space given to the subject is sufficient to cover all ordinary cases that occur in practice. Under the subject of belts many formulas are given, but belts, especially leather and rubber ones, are always proportioned by much simpler methods. The same is true of line shafting. While it is always well to explain the theoretical side of these questions, we still think that the practical methods should always be given, as they are the ones to be used in every-day work, and when a special case arises which calls for greater refinement, other works are at hand which treat exhaustively of that particular question.

The book is full of good references to other authorities, and this practice should be encouraged. The tables of ordinates at the end of the book for laying out the profiles of teeth are good, and easily applied when one understands them.

TRADE CATALOGUES.

Grant's Gear Book for 1892. *The Lexington Gear Works, Lexington, Mass.*

This book, while of course primarily intended to advertise the work done at the Lexington Gear Works, contains some excellent hints on the drawing of gear-wheels, both spur and bevel, and some discussion on the best form of teeth. It also contains a list of a great variety and number of sizes of gear-wheels made by the Works. A copy will certainly be convenient for any one who has occasion to use gearing of any description.

Manilla Rope Power Transmission as Applied by the Link Belt Machinery Company, Chicago.

Rope driving is not new, having been in use for a number of years, more perhaps in England and in European countries than in the United States. Lately, however, the use of rope for the transmission of power instead of leather belts or line shafting has commanded increased attention from engineers and manufacturers. The advantages of this method of transmission and the different ways of applying are well set out in this pamphlet, which contains also illustrations of a number of places where it has been applied. The Link Belt Company is prepared to make plans and estimates for transmitting any amount of power in this way.

Contractors' Earth-Moving Implements and Road Machines. The F. C. Austin Manufacturing Company, Chicago, Ill.

This handsome catalogue contains an illustrated description of the Austin Company's "New Era" grader and ditcher; the Austin dump wagon and the Austin reversible road machine and road roller, together with some other machinery manufactured by the Company, including their street sweeper, their stone-breaking machine for road purposes, their well-borer and their portable engine. The merits of the New Era grader and the road machine are very well known by the large number of engineers and contractors who have used them, or have seen their work, and but little needs to be said about them. The catalogue has something more than the mere description, for it gives some valuable hints on the best methods of using excavating machinery and of moving earth, and also some information on road making. The illustrations are very good of their kind, being well adapted to show the machinery and the manner of using it. Every engineer on construction work and every contractor would find a copy of this catalogue useful.

CURRENT READING.

In Goldthwaite's Geographical Magazine for August there is the usual variety of short, pithy articles, treating of River Valleys; the Yellow River; End Towns of the World; the Tehuantepec Inter-Oceanic Route; China and the Tea Trade; the Landfall of Columbus, and a variety of other topics. It must not be supposed that this magazine is for teachers or geographical specialists only; almost every intelligent reader can find something of interest in its pages.

Among the books in preparation by John Wiley & Sons, New York, is a Text-book on Experimental Engineering, by Professor Rolla C. Carpenter, of Cornell University.

The August number of the Arena was largely given up to women, and the September number continues the free discussion for which this magazine is noted. Both sides of the present political discussion are ably presented in its pages.

The Engineering Magazine for August has papers on Compressed Air for Street Cars, by General Herman Haupt; the Mississippi Problem, by C. N. Dutton and H. St. L. Coppée; Ornament in Architecture, by L. H. Sullivan; Underground Water in Arid Regions, by R. T. Hill; River Improvement at Portland, by G. W. Freeman; the Railroad of the Future, by Oberlin Smith; Gold Mining in the Black Hills, by H. M. Hanson; Practical Hints on House Heating, by L. Allen; Evolution of the Constructive Faculty, by J. M. Burnett. The special departments continue to improve.

Recent numbers of Harper's Weekly have given illustrated accounts of the progress of work on the Exposition at Chicago, an account of the Sault Ste. Marie Canal and other papers of value.

The first article in Good Roads for August is on the Demand for Better Roads, by Colonel J. A. Price. Other papers are on Cost of Labor; Convict Labor; Brick Pavement and a continuation of the series on Dirt Roads and Gravel Roads. The number is a very good one.

In Outing for August there are a number of bright, seasonable papers, making it an excellent number for summer reading. The illustrations are very good.

The August number of the Eclectic Magazine is very good reading also, and the selection of articles from English periodicals has been judiciously made.

The September number of Scribner's Magazine has articles on Buffalo Hunting, on the Pueblo Indians, on St. Petersburg and its chief street, on the Greely Expedition, and on the future of the Tilden trust. Besides these there are several stories and lighter articles.

The Popular Science Monthly for September describes the work done in the Marine Laboratory at Wood's Holl; it has a Study of Involuntary Movements, by Professor Jastrow; a paper on Infectious Diseases, by Surgeon Sternberg, of the Army, besides several other papers of much interest.

A complete and handsomely illustrated description of the Farallon Islands is the leading article in the Overland Monthly for September. Other articles describe the Redwoods of Northern California, and give an interesting chapter of War history never before published.

The September number of Harper's Magazine is fully up to the standard both in text and illustrations, and furnishes much solid reading, besides lighter and more entertaining matter.

BOOKS RECEIVED.

A Memorial to Congress on the Subject of a Comprehensive Exhibit of Roads, their Construction and Maintenance at the World's Columbian Exposition. Boston; Albert A. Pope.

Dynamometers and the Measurement of Power: A Treatise on the Construction and Application of Dynamometers. By Professor John J. Flather, Purdue University. New York; John Wiley & Sons. Price, $2.

Administration Report on the Railways of India for 1891–92. By Lieutenant-Colonel R. A. Sargeaunt, R.E., Director-General of Railways. Simla, India; Government Printing Office.

The Carolo-Wilhelmina Ducal Technical High School at Brunswick: Programme for the Scholastic Year 1892–93. Brunswick, Germany; issued for the School.

Transactions of the Liverpool Engineering Society: Volume XIII. Edited by J. H. T. Turner, Honorary Secretary. Liverpool, England; published by the Society.

Census of Canada, 1891. *Bulletin No.* 12. *Manufactures in Cities, Towns and Villages.* Ottawa, Canada; issued by the Department of Agriculture.

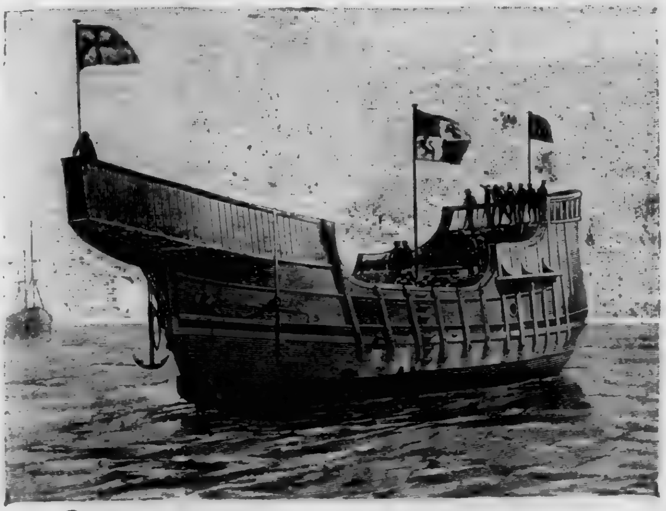
Selected Papers of the Institution of Civil Engineers. Edited by James Forrest, Secretary. London, England; published by the Institution. The present installment includes a number of papers by different members, and an abstract of recent papers in foreign transactions and periodicals.

Annals of the Society of Italian Engineers and Architects. Seventh Year, 1892; *Volume III.* Rome, Italy; published for the Society.

Some Moral Factors in the Engineer's Career. By Alfred R. Wolff, M.E. This is a reprint of an address delivered at the Commencement of the Stevens Institute of Technology.

SOME CURRENT NOTES.

THE great tunnel for the water-power works at Niagara Falls is now nearly completed, the Cataract Construction Company reporting 7,600 ft. finished. This tunnel, it may be noted, is 19 ft. in width and 21 ft. high in the center, and is lined with brick throughout. It is now expected that the first mills in connection with the water-power will be in operation early in 1893.



THE CARAVEL "SANTA MARIA."

THE American Iron & Steel Association reports, from the statistics furnished to it by the manufacturers, that the total production of pig iron in the United States in the first half of 1892 was 4,799,056 gross tons, against 4,911,763 tons in the second half of 1891, a decrease of 112,707 tons. Adding the production of the two half years, we have the extraordinary production of 9,710,819 gross tons in twelve months, which is 508,116 tons in excess of the production of 9,202,703 tons in 1890. Our production of pig iron in the twelve months of 1891 fell below that of 1890 because of the serious interruption to furnace activity in the first half of 1891, when we made only 3,368,107 gross tons, the total production in that year being 8,279 870 gross tons.

THE production of Bessemer steel ingots in the United States in the first half of 1892, as reported to the American Iron & Steel Association, was 2,305,999 net tons, as against 1,599,096 net tons in the first half and 2,038,011 tons in the second half of 1891. The increase this year over the corresponding period in 1891 was thus no less than 706,903 tons, or 44 per cent.

The production of steel rails in the first half of the present year was 865,128 tons ; an increase of 285,199 tons, or 49 per cent. over the first half of 1891, and an increase of 13 per cent. over the second half of last year.

WHEN the Broad Street Station of the Pennsylvania Railroad in Philadelphia was built, the company believed that it would serve its purpose for many years to come. Already, however, it has become too small to accommodate the increasing travel, and work has begun on its enlargement. According to the plans there will be a ten-story building erected at the corner of Broad and Market streets, 200 ft. high, running 50 ft. west of Fifteenth Street. The total dimensions of the depot, when completed, will be 306 × 212 ft. The train shed will be the largest known, 598 ft. 8½ in. long, and with a span of 304 ft. The order for the iron and steel is the largest of the kind ever given out in Philadelphia, and will require fully 10,000 tons of plates, girders, etc. It is expected that all the additions and alterations will be made before the opening of the World's Fair next spring.

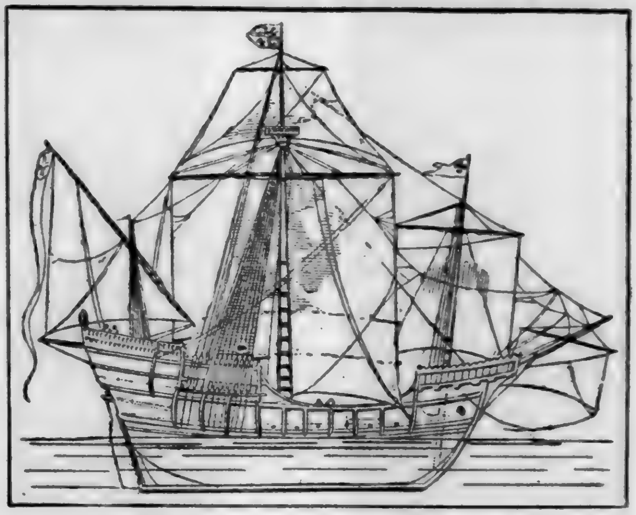
THE Highway Commission appointed under the new Road Law of Massachusetts has begun its work by asking for information from the town and city authorities throughout the State. The present object is to ascertain the methods followed, the authorities having charge of the roads, the cost of maintenance, the general condition and other particulars. Upon the information collected the Commission will base a report to the Legislature, which is expected to include practical recommendations for a general highway law.

THE caravel *Santa Maria*, built in Spain and as nearly as possible a reproduction of the ship in which Columbus made his voyage in 1492, sailed from the port of Palos, August 3, on the four hundredth anniversary of the beginning of the original voyage. The sailing was accompanied by appropriate ceremonies. Under the convoy of a Spanish war-ship the *Santa Maria* will repeat as nearly as possible the voyage of four hundred years ago.

The sketch given below shows the general appearance of the *Santa Maria*, which will be seen in this country in due season. The upper illustration (from *Engineering*) is from a photograph of the *Santa Maria* taken immediately after her launch. It may be added that she was built by the Spanish naval authorities, and that reproductions of her two consorts, the *Pinta* and the *Nina*, are now being built in Spain, at the expense of the United States.

THE contractors for the building of the proposed lighthouse on the Diamond Shoals off Cape Hatteras gave up the contract, as recently noted, the difficulties encountered being so great that even engineers of such experience and resources as Messrs. Anderson & Barr despaired of overcoming them. The Lighthouse Board, however, does not give up the project, and new plans for establishing the light are now being prepared.

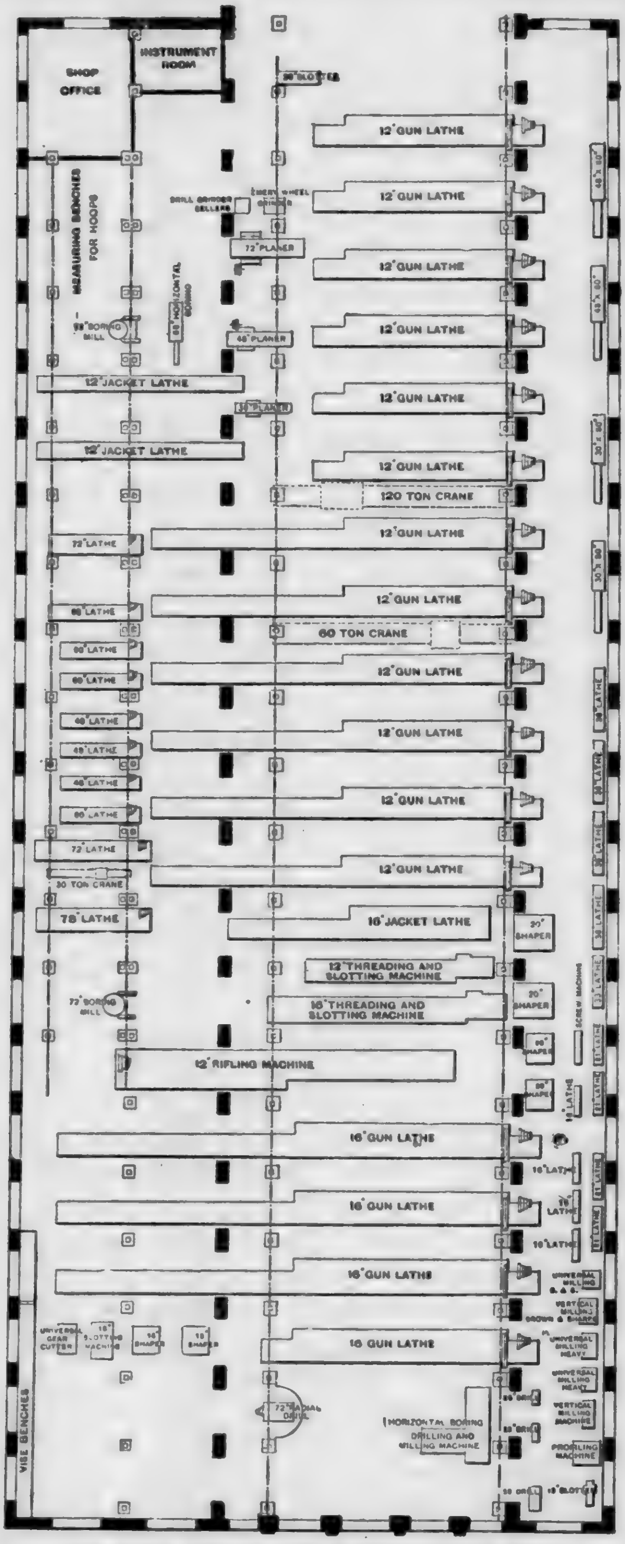
THE record for speed on a transatlantic trip is at present held by the *City of Paris*, which has made the run from Queenstown to Sandy Hook in 5 days, 15 hours, 58 minutes, or 33 minutes less than the time made by the *Teutonic* a year ago. The actual distance run by the log was 2,785 knots ; the best day's run was 520 knots, and for four consecutive days the ship made over 500 knots a day. The average speed for the entire voyage was 20 48 knots, and that of the best day 21.67 knots an hour.



THE CARAVEL "SANTA MARIA."

THE WATERVLIET GUN-SHOP.

THE accompanying illustration, from the *Iron Age*, is a plan of the new south wing of the gun-shops at the Watervliet Arsenal, showing the arrangement of the machinery in this wing. It corresponds to the north wing built some time ago, but has not the same width, being 400 × 154 ft. in size. With the central building the total length of the gun-shop is now 958 ft. The central building contains the forges, shrinkage pit, boiler and engine-room. The plan of the south wing given conveys a comprehensive idea of the tools which will eventually occupy it, a number of which are already under construction. When they



THE SOUTH WING OF THE WATERVLIET GUN SHOPS

are completed the shop will be in condition to handle without difficulty guns of the largest size yet designed by the Ordnance Department.

The eastern extension of the south wing is 22 ft. wide and the western extension 50 ft. The central portion is 76 ft. between the walls and 60 ft. from center to center of the columns carrying the cranes. The height from the floor line to the peak of the roof is 75 ft. Except at the central or shrinkage-pit section, which has a monitor roof, the entire building is lighted from the sides and ends, and we may here state that it is one of the best lighted shops we ever entered.

At the present time there are three boilers and one 250 H.P. Fitchburg engine furnishing power for the north wing. When the boiler and engine-rooms were designed space was provided for the engines and boilers necessary to run the south wing.

The crane track in the north wing is 50 ft. wide, and on it travel two 30-ton square-shaft cranes; the track in the other wing is 60 ft. wide and upon it are two Morgan electric cranes, one of 60 tons and the other of 120 tons capacity. At the shrinkage pit the two tracks have been extended past each other, so that the cranes from either wing can be brought into service handling guns at that point.

A RAPID STEAM CRANE.

THE accompanying engraving is from a photograph of one of three steam-power cranes built by the Detroit Foundry Equipment Company, Detroit, Mich., and placed on the steamer *Pioneer*, built for the Cliffs Iron Company, of Cleveland, O., by the Detroit Dry Dock Company. These cranes were specially designed for loading and unloading pig iron, and are very rapid in their work. The motive power, it will be seen, consists of a double upright steam-engine acting on the shaft which carries the spur gear. Both the hoisting and the revolving are done by steam power, and the crane is very easily and quickly controlled. The whole construction is so well shown in the engraving that but little description is needed. In use they have given full satisfaction.

The steam crane of this class is something of a novelty on the lakes, the *Pioneer* being the first steamer to be supplied with them. It is evident that they must be a very useful addition to a ship's equipment, as they can be of great use not only in loading and unloading, but also in lightening cargo in case of accident by running aground. The lake shipowners have shown themselves usually very apt to adopt improvements, and the use of these quick-working steam cranes seems to be one which will commend itself to them.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.*

CHEMICAL METHODS.—INTRODUCTORY.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

IT is proposed to give, in a series of articles in this JOURNAL, of which this is the first, the chemical methods in use in the Laboratory of the Pennsylvania Railroad. These methods are a part of the official specifications on which materials are bought, and, of course, like specifications, are subject to revision and modification from time to time as new knowledge develops. It is hardly necessary to say that the appearance of these methods in this JOURNAL is simply for public information, and that the road is not at all bound by what appears in this JOURNAL. It is intended that the methods as they appear from time to time shall correspond exactly with the state of affairs at the time, but it frequently happens that slight changes or modifications are introduced in the official copy of specifications or methods that could not be made after the article has once appeared in this series, so that those whose interests are affected must be guided by an official copy obtained in the proper way.

There are a number of reasons why it has been decided to make public the chemical methods in use in the Pennsylvania Railroad Laboratory, and to make these methods a part of the specifications.

First, the specification attempts to tell the manufacturer what is wanted. It is therefore simply fair that the manufacturer of any product should know what tests the material is going to be subjected to, and exactly how the tests are to be applied. It is hoped to make the publication of

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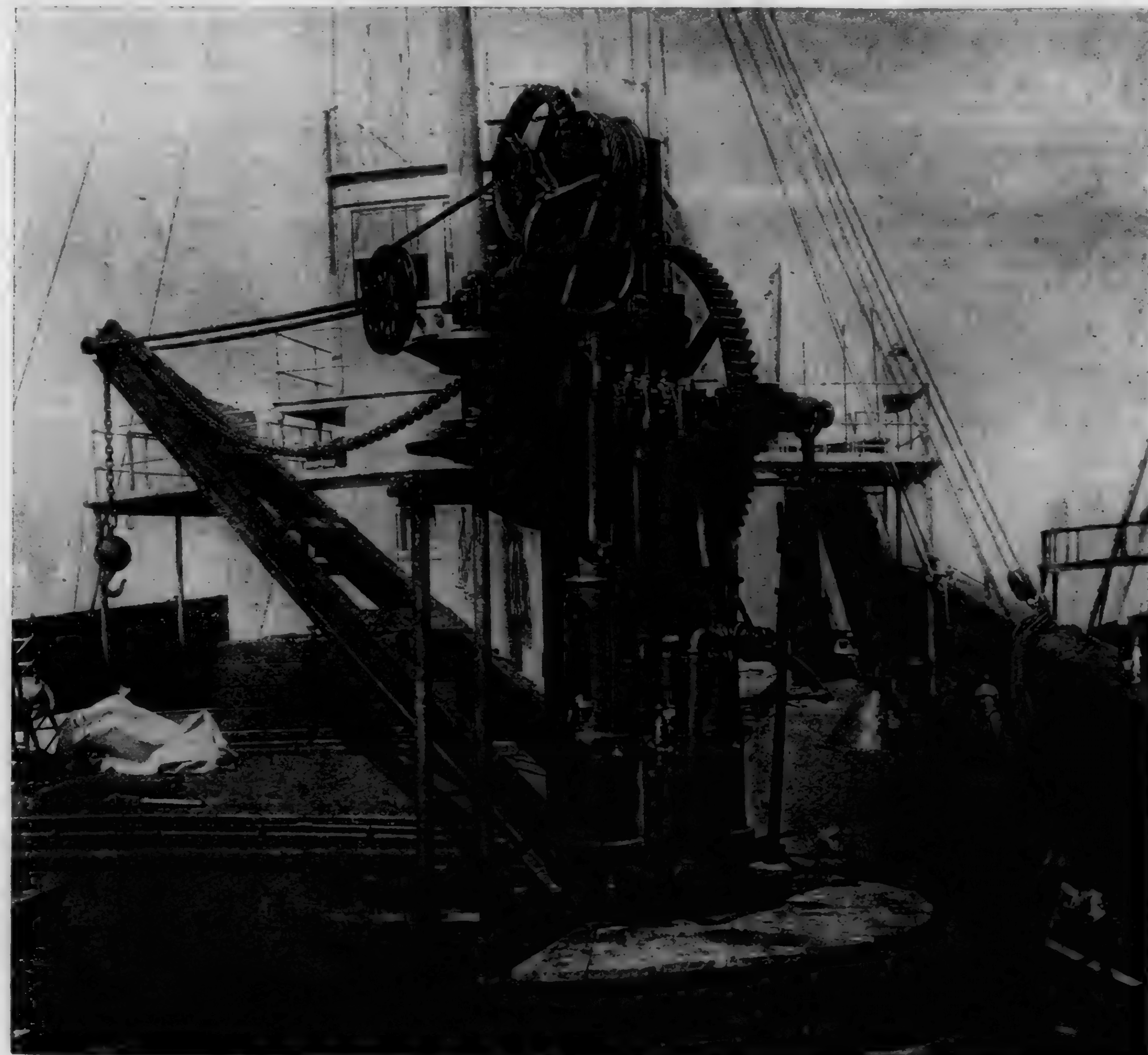


STEAM DERRICK FOR STEAMER "PIONEER."

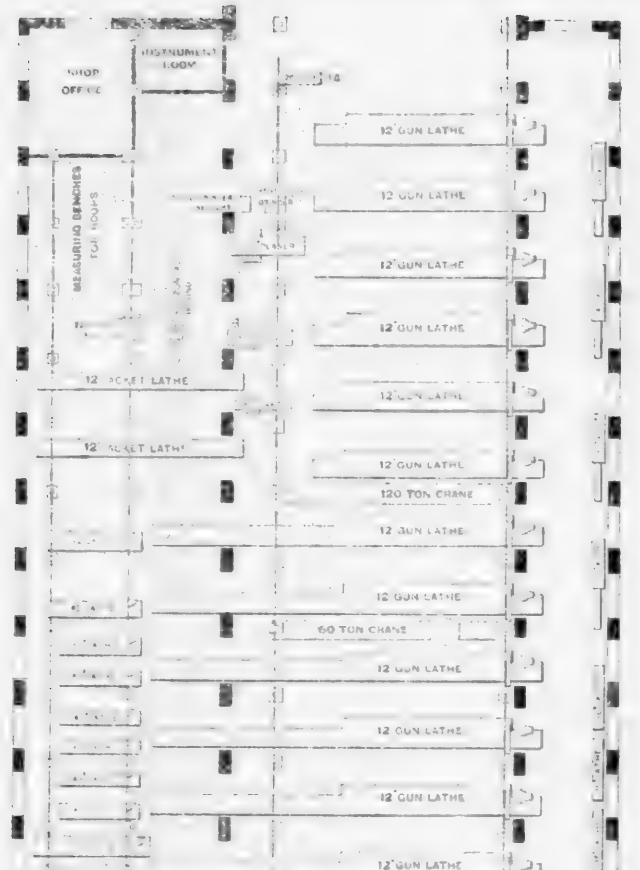
BUILT BY THE DETROIT FOUNDRY EQUIPMENT COMPANY.

the methods sufficiently minute and definite, so that any one possessing good chemical training will be able to use the methods exactly as they are used in the Pennsylvania Railroad Laboratory, and get corresponding results. Illustrations of apparatus will be given where it is thought they can throw any light on the method.

A *second* reason for giving the methods is the avoidance of disputes. It is well recognized by those who are constantly using the results of chemical analyses that different chemists differ somewhat in their analysis of the same product. There are believed to be four causes for discrepancy in chemical analyses. These four causes are as follows:

First, the sample worked on by the two chemists is not the same. This is a frequent cause of discrepancy in chemical analyses. We have many times been met with discordant statements as to what a certain lot of material shows on analysis. On investigation we often find that the material in question is a carload consisting of, say, 50 to 75 barrels, and that the two or more chemists had not obtained their sample from the same barrel. If we may trust our experience, it is a very common error for manufacturers and many times consumers to suppose that because a certain amount of material was shipped in one car, or even in one barrel, that therefore the material is uniform. It is well recognized that the obtaining of a uniform sample is one of the uncertainties that must necessarily attend all commercial products. It has been previously stated that by design we take a sample from a single package, and that one sample must represent the shipment. It follows, therefore, that if there is a discrepancy between two chemists in examining the same lot or shipment of material, this discrepancy may be due to difference in the samples on which the two chemists worked. This difficulty is not at all a serious one, since it is very simple to exchange samples. We have many times done this, and in all our regular routine work always retain a sample from a condemned shipment for two weeks, so that the party shipping the material can have a sample of the material which we worked on if he desires.

The *second* reason for discrepancy in analyses is impurities in the chemicals. Reagents marked "chemically pure" many times contain serious amounts of material that affect the analysis. Of course no chemist would ever think of making an analysis without checking up the chemicals used. This may be done apparently in two ways, either by a test of the chemicals to see that they do not contain injurious constituents, and second, by making a "dummy" analysis alongside of the real one, using in this dummy analysis the same amounts of all the chemicals as are used in the case of the real analysis, but without having any of the material to be examined present. Of course all the impurities found in the dummy analysis at the end are deducted from the result obtained in the real analysis. This method of making a dummy analysis is, of course, applicable in many cases. We are hardly



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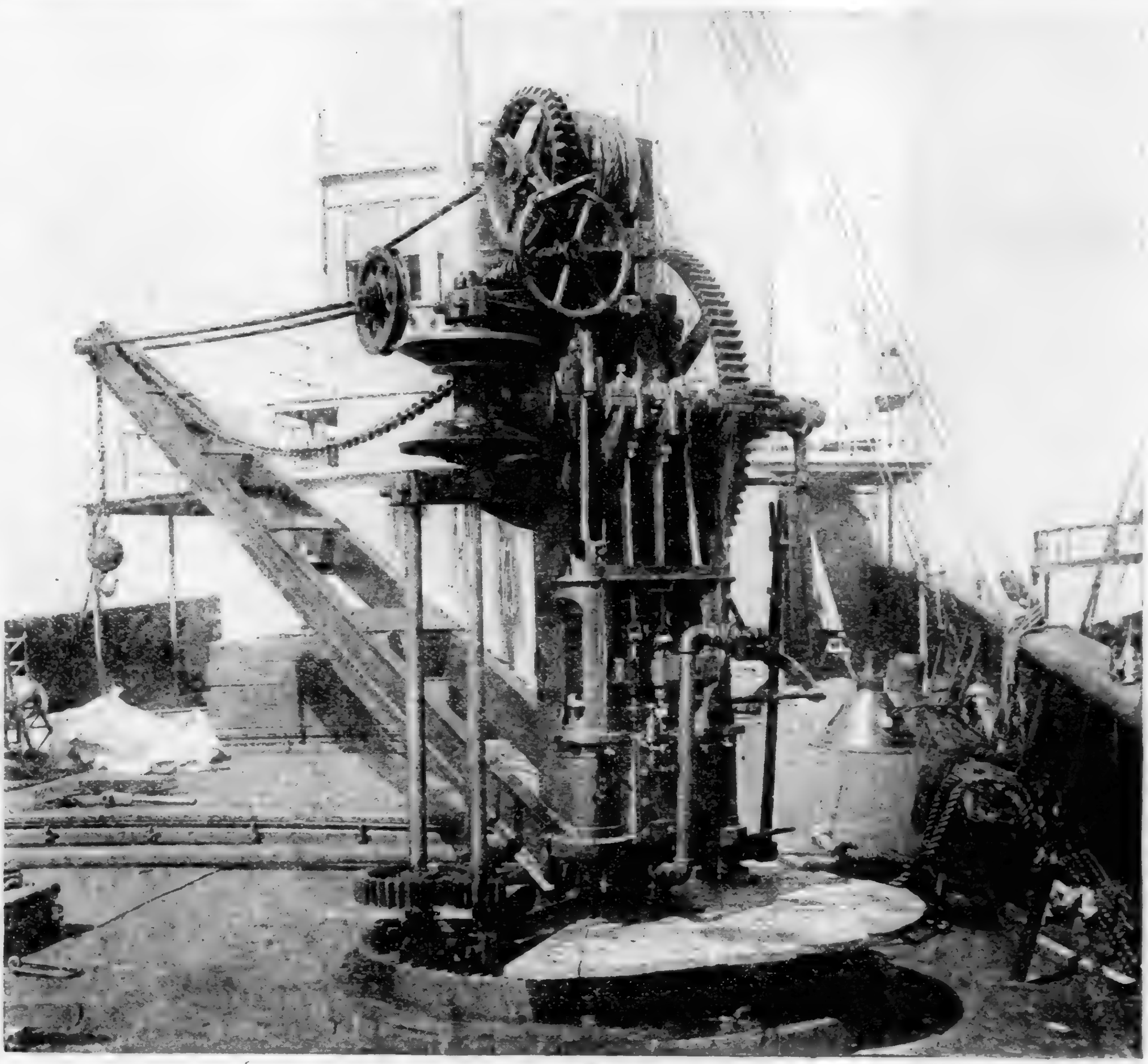

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willing to say that we think it is a complete check on errors due to impurity of chemicals, since we do not know that in all cases the same reactions will take place with the chemicals alone that would take place if the substance to be analyzed was present. The best way, of course, is to have chemicals free from injurious substances. So far as difficulties arising from discrepancies between chemists due to this cause are concerned, there is no serious trouble in locating them. In test cases it is not at all uncommon for chemists to swap chemicals in cases of discrepancy, and these three things—namely, testing the chemicals, the dummy analysis, and the swapping of chemicals would, without doubt, locate the difficulty if it was due to impurities in the chemicals.

The *third* cause for discrepancy in chemical analyses is what may be embraced under the general heading of "poor manipulation." This is clearly a question of the skill and judgment of the chemist. Hundreds of illustrations might be given of how the manipulation affects the analysis. In filtering one chemist spills a few drops while another does not. Again, the method requires that the liquid shall be at a certain temperature. One chemist uses a thermometer, and the other guesses at it. Again, the method requires that a certain amount of a certain reagent shall be used. One chemist measures it, another guesses at it. Again, one chemist takes into account the impurities in the air or dust, and takes special means of keeping these out; another one ignores this little source of error, and so on. It is obvious that this might be a quite serious source of discrepancy between chemists, and there are those who think and state that this is the principal source. An old teacher of chemistry once said in our presence, "No chemist can make an absolutely accurate analysis. There are chemists who can work near enough to accuracy so that their work is valuable; there are others who cannot." As a means of overcoming the discrepancy due to lack of skill or what is commonly termed "manipulation," the two chemists who disagree, and who desire to find the cause of the difficulty, may get together and make an analysis each in the presence of the other. This is frequently done, especially in assaying. Many times it is not necessary to go as far as this. A talking over of the methods of procedure will usually locate the difficulty.

With regard to the above three sources of discrepancy in chemical analyses, it will be observed that there is no serious difficulty in finding the cause of the discrepancy and of making the analyses agree by finding this cause. This is not the case, however, with the method. A discrepancy in the results due to a difference in the method used is one that no amount of work or checking up of chemicals or interchange of samples will eliminate. The discrepancy is inherent. It is well recognized by those who are familiar with chemical work that a number of different methods may be made use of, or modifications may be introduced into a single method by different chemists, which will vary the result somewhat, and there is as yet no agreement, at least in this country, so far as we know between chemists, except in a limited degree among agricultural chemists, as to what method shall be regarded as standard and be used in case of dispute. As long as there is no such agreement it is very difficult to adjust these discrepancies due to method. Each chemist claims that the method he uses is as good, or perhaps better, than the other, and that the results he obtains are the correct ones. It is obvious that no amount of talk or discussion will bring such parties together, and it is this state of affairs that has led us to the idea of making the method a part of the specification. This, we think, will eliminate the *fourth* cause of discrepancy in chemical analyses.

There is still a third reason why we think it is advantageous to make the methods a part of the specification—namely, some of the methods which we use have not yet been put in print, which is due to the fact that we are examining commercial products which have not previously been much worked upon, and there are no methods among those published which are entirely applicable. We have a number of times had to devise methods for the examination of a new product. Parties desiring to check up our work, therefore, cannot look to any of the books or published methods for information as to how these products are examined.

It will, of course, be understood beforehand that there is no assumption of such superior knowledge or skill on our part as entitles us to dictate to the profession. We are trying to meet the difficulties which arise in our work in the best way we know how, and for this purpose make the method a part of the specification, and use such methods as in our judgment are best and most applicable to the work. It is well recognized by all chemists that there may be some methods better than others, but that the best methods are many times so long and laborious that they are inapplicable to such work as may be in hand. It may happen, therefore, that a method will be used that is not absolutely the best so far as extreme accuracy is concerned, but is near enough to accuracy for the purpose in hand, and has the additional advantage of being more rapid.

This use of methods not characterized by the highest possible degree of accuracy can introduce no difficulty, since by the plan which we pursue of making the method a part of the specification, we only require in the specification that the constituent in question shall conform to the limits shown by the method given. For example, suppose that the most accurate method known shows that a piece of steel contains 0.51 per cent. manganese, and that the method which we use shows this same piece of steel to contain 0.50 per cent. manganese. Here is an error of 0.01 per cent. of manganese, which proportionally would pervade all determinations of manganese made by our method. But our limitations are based on the determinations made by our method, and therefore, although this method might give results above or below the actual truth, it introduces no hardship.

It is, of course, essential that the method we employ shall be reliable and uniform in its indications—that is to say, a number of different analyses made of the same sample by this method must agree with each other within reasonable limits of error, or the method is worthless; and it will, of course, be our duty to take care that this point is covered in the methods given.

Among the advantages which we anticipate will result from giving publicity to the chemical methods which we use is the criticism of these methods, which will come as the necessary resultant of their publicity. Recognizing as we do that there is more or less uncertainty in all chemical methods, it is our sincere hope that sufficient criticism will be put upon the methods as they are put forth from time to time to check up any errors or flaws in them. The fact that a method is made a part of the specification and put in print should not in any sense prevent criticism of the method. A demonstrated error in the method will be accepted and recognized at once and modifications introduced. It is clear that such criticism on the part of other chemists, and modifications of methods which they may suggest, or which may come as the result of our own study, will have a tendency to develop chemical methods for the examination of commercial products which sooner or later can fairly be regarded as standard, and while we do not at all attempt to assume that such methods as we may put forth can now be regarded as standard in any other sense than as applying to the materials purchased under specifications of the Pennsylvania Railroad, it is our sincere hope that sufficient study and criticism will be put upon these methods as they appear from time to time by other chemists, so that sooner or later, and after a proper period of development, the profession will be willing to accept them as standard methods.

(TO BE CONTINUED.)

COMPOUND LOCOMOTIVES IN THE WORLD.

AT the session of the International Railroad Congress in Paris, in 1889, the Compound Locomotive was one of the questions submitted for discussion and report at the meeting of the Congress to be held at St. Petersburg dur-

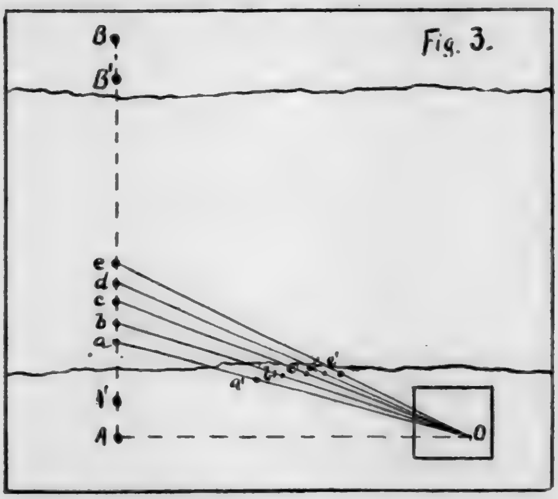
ing the current year. The reporters to whom this question was assigned were MM. L. Parent, Chief Engineer of Motive Power of the French State Railroads, and Concanargues, Chief Assistant Engineer of Motive Power of the Paris, Lyons & Mediterranean Railroad.

These gentlemen have prepared an elaborate and interesting report, in which they have given a condensed account of the various types of compound locomotives thus far brought into use, and of the experience had with them in service. The general tenor of the report is well expressed in its closing paragraphs, which we give below:

CONCLUSION.

The advantages of the compound type are not yet proved to the satisfaction of all railroad engineers. Its partisans are indeed more numerous than the opponents, and the applications, as we have seen, have increased from 680 to 1,858 in less than three years. These figures may be analyzed as follows: Two-cylinder locomotives have increased from 522 to 1,371; three-cylinder from 99 to 108; four-cylinder from 59 to 379. This very great increase is certainly due in great part to the general increase of pressure carried in locomotive boilers, which requires either double expansion or better valve motions to utilize it. The majority in favor of the two-cylinder type remains strong, but in proportion the four-cylinder type has made the greatest progress, thanks to the very considerable aid furnished by America, which up to 1889 had paid little attention to this question, but reports already 123 in the figures above. The American engines with four cylinders are almost all of the type with the cylinders side by side, first proposed in France in 1882, but actually perfected and brought out in 1890 in the name of the Vauclain type.

The result obtained from trials of long continuance which are still too few, but which have been made carefully by different companies between simple and double-expansion locomotives differing only in the application of the compound principle, is that the double-expansion engine shows an economy in fuel of 8 per cent. at the least, when the pressure of steam is 125 lbs. only, without any considerable increase in the expenses of lubrication or



maintenance, at least when two cylinders only are used. This economy of fuel certainly increases with the increase in boiler pressure.

Our conclusion will not differ from that of the report presented to the third session.

"If in countries where coal is cheap, it is not of advantage to change ordinary locomotives into compound locomotives nor perhaps to build new compound locomotives at a moderate pressure, it is certainly of advantage in countries where fuel is dear to build new engines at high pressure on the compound principle, and even to change to compound the existing locomotives when the boilers are in condition to carry a high pressure."

The new discussion to which the examination of the compound question will give rise will probably permit us to decide, moreover, if it is preferable to use two, three, or four cylinders; if it is best to make use of automatic starting apparatus or not; and finally, if we approve of four-cylinder engines, what is the best arrangement of the cylinders to recommend.

We do not think that the question of the use of the triple-expansion locomotive can be usefully or advantageously taken up at this meeting.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

(*Continued from page* 364.)

DETERMINATION OF CROSS-SECTIONAL AREA.

The methods applied for the determination of the cross-sectional area and of the average velocity in a vertical vary according to the width of the river.

When the river is not very large—200 to 300 ft. in width—then a double cable or steel wire can be thrown across, and the observer, traveling along this cable or wire, can measure the depth of the water and its velocity at equally distant points (as shown by the cable or wire).

When the river is larger, say from 300 to 1,000 ft. in width, then the cable or wire can be still applied, but it should be supported by small boats held by means of anchors 200–300 ft. apart.

When the width of the river is more than 1,000 ft., then no cable or wire can be thrown across it, and the observer is obliged to travel in a boat across the river, following the line of cross-section laid down on the shores by means of posts, and to stop at some points by means of anchors. His position is then determined by means of some angle-measuring instrument.

Of course, it is very important for the facility of computations, that the measurements of depth and velocity be taken at equal intervals. It can be easily arranged so that the observer will travel in the cross-section line *A B*, fig. 3, and stop in the points *a, b, c, d* . . . . at the crossing of some previously fixed direction line. For this purpose it is enough to draw on the shore a base *A O*, say perpendicular to the cross-section *A B*, and in the point *O* fix the theodolite or the surveyor's table. Then the points *a, b, c, d* . . . . being designed on the topographic plan of the river at equal distances, it is not difficult to fix their positions by means of the surveyor's instruments, or by computing the angles *a O A, b o A, c o A*, ... This method requires two observers at once, one in the boat, the other at the point *O*. But the task of this second observer can be facilitated by driving posts on the shore, at the points *a', b', c'* . . . . in the direction of the lines *O a, O b, O c*, ..., and then putting a large post in the place of the instrument *O*. The required points *a, b, c*, ... will be then fixed as the cross points of the line *A A'* and of the directions *O a', O b', O c'* . . . . .

The measuring of the depth and velocity should be performed in calm weather, and the best vessel for that purpose is a kind of raft, a platform built on two boats 10 to 14 ft. apart, and retained by means of two anchors.

The measurement of depth is made by means of a wooden post for small depths, or by means of a leaden weight or log hung on a cable or wire.

For the measurement of velocity of water for depth under 15 ft., the best instrument is the hydrometric apparatus* of Woltmann, Baumgarten, or Amsler on an iron tubular rod; for depths more than 15 ft., the Amsler apparatus with electric signals, steel wire, or winch and special hoisting apparatus should be applied. In the latter case the apparatus is sunk on a wire by means of a winch placed in the center of the platform. Of course it should

* Moulinet.

be sunk from the upper side of the platform. A sketch of the apparatus is shown in fig. 4.

The boats are kept in their place by means of two or four anchors, as may be found necessary.

The form of the platform can be varied as it may be found convenient. One form is to be seen in the accompanying sketch, which is drawn from a photograph, showing the observations made on the Irtish River.

The measurements of velocity in one cross-section of the river should be performed at such intervals of time that the water level and generally the state of the river do not vary sensibly; consequently the work should be finished in one day—say, from 10 to 15 hours.

Now, as in a day of 10 to 15 hours it is difficult to make more than 15 to 18 complete measurements in a large river without the cable, and no more than 30 to 40 measurements with the cable; therefore, in the case of great rivers, 1,000 to 1,500 ft. wide, it is enough to make the measurements at intervals of 100 to 200 ft., and in small rivers at 50 to 100 ft.

THE DETERMINATION OF AVERAGE VELOCITY IN A VERTICAL.

In order to get the approximate average velocity of water in a vertical, it is sufficient to measure the velocity at a point of that vertical, distant from the water-level 0.6, or exactly 0.577, of the total depth of water or total length of the vertical. Professor Beleloubski applied this method when determining the discharge of the Dnieper River for the design of the Ekaterinoslav bridge.

In order to get a more exact value of the average velocity in a vertical, the best method is the following: Measure the

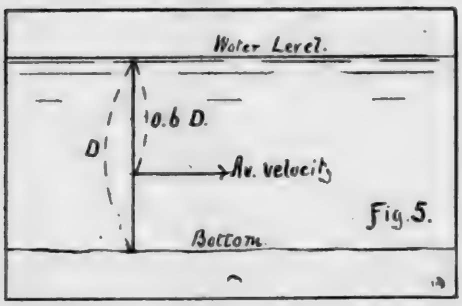


Fig. 5.

velocity at three points of the vertical; near the water-level, at the middle of the depth, and near the bottom, and from these three measured quantities calculate the average velocity, supposing that the velocities in a vertical change as the co-ordinates of the curve defined by the equation

$$v = A + B z + C z^2, \qquad (1)$$

in which the water-level is the axis of abscissæ and the vertical the axis of ordinates. The average velocity v_m will be equal to the area of the curve—*i.e.*, between the curve and axis of co-ordinates—divided by the total depth or length of the vertical.

Mr. Gnousin, a Russian civil engineer, who has performed many hydrographic and hydrometric surveys of rivers in Russia, in an article about the determination of velocities and discharges, advises for the sake of convenience that the three measured velocities be taken at the following depths expressed in fractions of the total depth.

Total Depth in Feet (z).	Three Depths from the Water-level in Fractions of Total Depth.		
	I.	II.	III.
2 to 4	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$
4 to 10	$\frac{1}{6}$	$\frac{1}{2}$	$\frac{5}{6}$
10 and more	$\frac{1}{10}$	$\frac{1}{2}$	$\frac{9}{10}$

We will develop the above formula (1) for each of these cases, and deduce the final formula for the average velocity.

In the first case, when the total depth z = 2 to 4 ft., the velocities are measured at depths equal to $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of that depth—viz., $\frac{1}{4}z$, $\frac{1}{2}z$, $\frac{3}{4}z$—if that depth is 4 ft., the partial depths will be 1, 2, and 3 ft.—and the formula (1) being applied here gives

$$v_{\frac{1}{4}} = A + \tfrac{1}{4} B z + \tfrac{1}{16} C z^2$$
$$v_{\frac{1}{2}} = A + \tfrac{1}{2} B z + \tfrac{1}{4} C z^2$$
$$v_{\frac{3}{4}} = A + \tfrac{3}{4} B z + \tfrac{9}{16} C z^2.$$

Resolving these equations, we can get the values of the

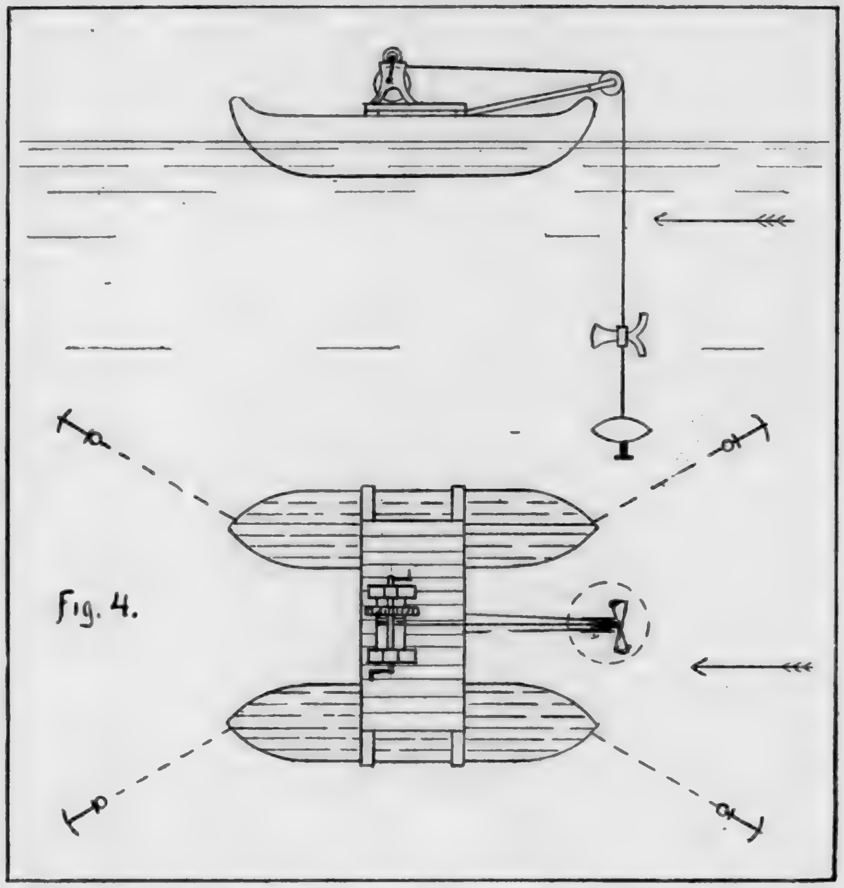


Fig. 4.

coefficients A, B, C, or better the values of A, $B z$, $C z^2$—viz.,

$$A = 3 v_{\frac{1}{4}} + v_{\frac{3}{4}} - 3 v_{\frac{1}{2}}$$
$$B z = 2 \left(8 v_{\frac{1}{2}} - 5 v_{\frac{1}{4}} - 3 v_{\frac{3}{4}}\right)$$
$$C z^2 = 8 \left(v_{\frac{3}{4}} - 2 v_{\frac{1}{2}} + v_{\frac{1}{4}}\right).$$

Therefore the average velocity will be

$$v_m = \frac{1}{z} \int_0^z (A + B z + C z^2)\, d z$$
$$= A + \tfrac{1}{2} B z + \tfrac{1}{3} C z^2,$$

or putting here the values of A, $B z$ and $C z^2$, finally

$$v_m = \frac{2 \left(v_{\frac{1}{4}} + v_{\frac{3}{4}}\right) - v_{\frac{1}{2}}}{3}.$$

For the second case, when the total depth z is equal to 4 to 10 ft., and the velocities are measured at the partial depths $\frac{1}{6}z$, $\frac{1}{2}z$, and $\frac{5}{6}z$, by means of the same calculations as above, we get the formula

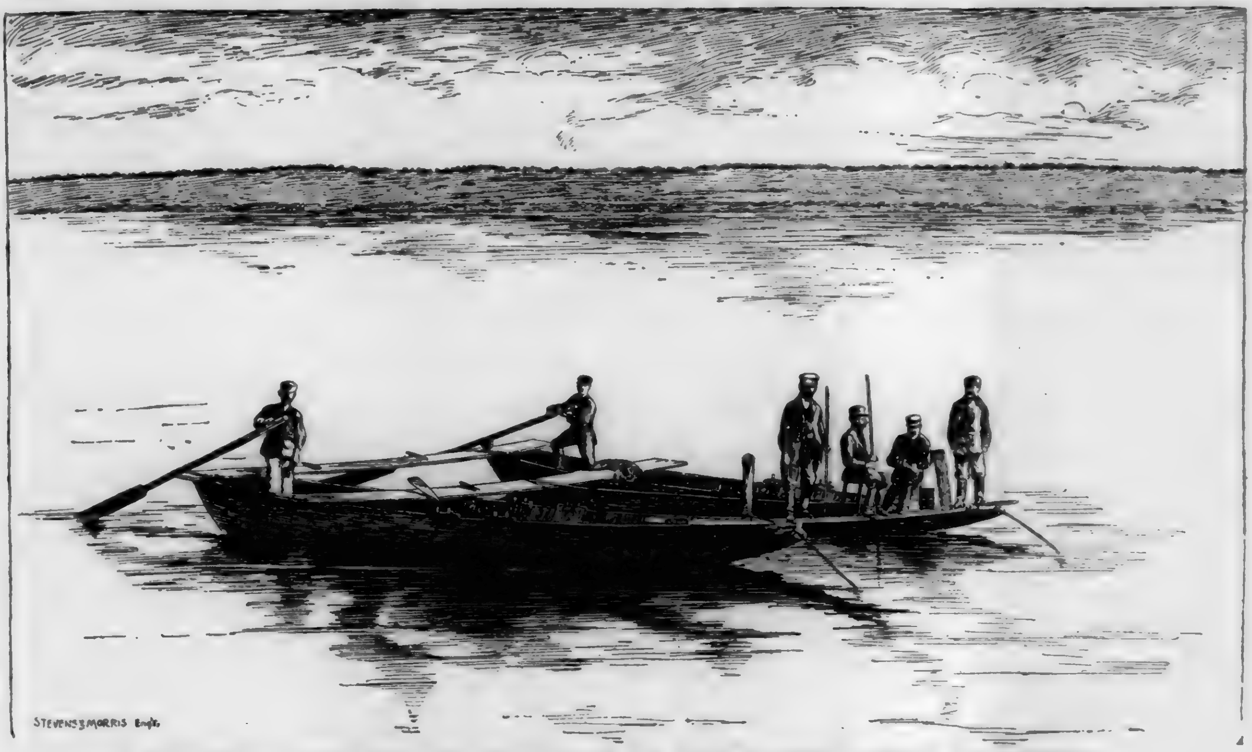
$$v_m = \frac{3 \left(v_{\frac{1}{6}} + v_{\frac{5}{6}}\right) + 2 v_{\frac{1}{2}}}{8}.$$

For the third case, when the total depth z is more than 10 ft., and the partial depths are $\frac{1}{10}z$, $\frac{1}{2}z$, and $\frac{9}{10}z$, we get the formula

$$v_m = \frac{25\,(v_{\frac{1}{10}} + v_{\frac{9}{10}}) + 46\,v_{\frac{1}{2}}}{96}.$$

In order to verify the availability of the above supposition, it is advisable to measure in a few verticals the velocity at many points separated by small intervals, and from this immediate measurement calculate the average velocity.

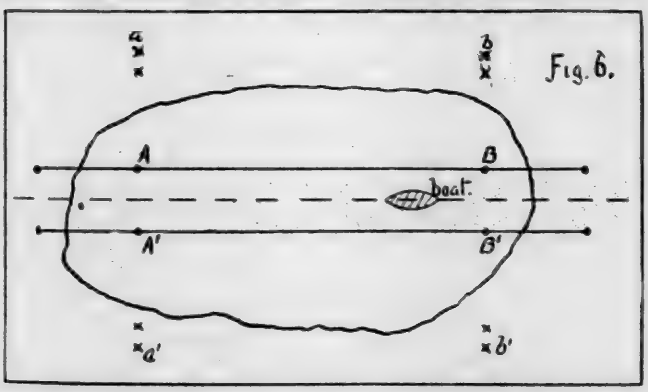
The average velocity in a vertical can be also determined by the method of Treviranus, which consists in slowly sinking the hydrometric apparatus from the water-level to the bottom or inversely (allowing three seconds or more for each foot of depth), and calculating the velocity corresponding to the total number of revolutions divided by the depth.



MEASURING DEPTH AND VELOCITY OF THE IRTISH RIVER IN SIBERIA.

THE MEASUREMENT OF VELOCITIES.

As above said, the most suitable apparatus for measuring the velocities of current at different depths are the hydrometric apparatus—*Moulinet, Flügel*—of Woltmann, or of Baumgarten, or of Amsler, the last with electric signal (bell) and winch for great depths.



In the portions of the cross-section where the velocity is very small floats can be used.

Applying the above hydrometric apparatus, the velocity of current is calculated by the well-known formula

$$v = a + b\,n,$$

where n is the number of revolutions in a second, and a and b the constant coefficients to be determined from experiments in stagnant water.

For that purpose a pond or a small lake should be chosen; from one shore to the other two parallel leading ropes should be drawn, and between them a boat placed with the observer, as shown in fig. 6. The boat is to be put in motion by means of two ropes attached to the bow and to the stern. The hydrometric apparatus should be immersed from the front end of the boat, and as far as possible from it; the observer notes the time of motion and the number of revolutions (reading the quadrant without using the electric signal). The distance travelled over by the boat is measured by means of marks made on the leading ropes ($A\,A'\,B\,B'$) or by means of posts ($a\,a'$ and $b\,b'$) placed on the shores and giving two directions perpendicular to the line of motion of the boat. It is enough that the path of the boat be 100 to 150 ft.

The velocity given to the boat by means of a rope and men, moving in a direction perpendicular to the shore, can be varied from $\frac{1}{2}$ ft. to 4 ft. in a second; however, it would be desirable to reach a still greater velocity, say, 5 to 6 ft. In order to calculate duly and with sufficient accuracy the coefficients a and b, it is necessary to make from 25 to 50 observations with different speeds of the boat.

If we designate by s the path traveled by the boat, by t the time required, and by N the total number of revolutions, then the fractions $\frac{s}{t}$ and $\frac{N}{t}$ will give us the velocity of motion v, and the number of revolutions in a second—viz.,

$$\frac{s}{t} = v, \qquad \frac{N}{t} = n,$$

and from the series of these quantities, by means of the method of least squares, the coefficients a and b will be calculated by the formulæ

$$b = \frac{m\,\Sigma\,n\,v - \Sigma\,n\,\Sigma\,v}{m\,\Sigma\,n^2 - (\Sigma\,n)^2}$$

$$a = \frac{\Sigma\,v - b\,\Sigma\,n}{m},$$

where m is the number of observations made in stagnant water and Σ the ordinary sign of summing up.

In calculating these coefficients in feet, it is quite sufficient to calculate the coefficient a with one or two decimals, and the coefficient b with two or three decimals.

The observations of the velocity of the current, made by

means of the hydrometric apparatus with electric signal, consist in noting the time corresponding to every 100 revolutions, marked by the sounding of the electric bell. Each of such observations should last from two to three minutes, in order to include the period of fluctuations of the velocity of the current, which in great rivers is generally equal to that interval of time—two to three minutes.

THE MEAN VELOCITY OF A CROSS-SECTION CORRESPONDING TO THE HIGHEST WATER-LEVEL.

Having thus determined the maximum discharge, corresponding to the highest water-level in a cross-section of the river, it is very easy to find the mean velocity of the whole cross-section, by dividing this discharge by the whole area of this cross-section.

The knowledge of that mean velocity is especially needed for the reason that, according to Weissbach, it is approximately equal to the maximum velocity on the bottom, the knowledge of which is necessary for stating the conditions of the washing out or sweeping of the river-bed.

TOPOGRAPHIC PLAN OF THE PART OF THE RIVER AND ITS INUNDATION OR FLOOD LIMITS.

At least a mile above and a mile below the point of the river crossing, and in addition at the normal portion of river chosen for the determining of discharge, the limits of floods should be accurately topographically leveled on a scale of $\frac{1}{5,000}$ or $\frac{1}{10,000}$. The plan should show the river shores at the lowest level of water, the limits of inundation; in the plan of the river channel the lines of equal depths and the direction of the current, and in the limits of inundations the horizontal lines and the direction of the general current and of particular currents, in secondary channels if there are any, during the highest flood.

The surveying can be performed by means of the surveyor's table or theodolite, and when the width of the river is very great, the shores may be connected by means of triangulation, which should be the base for the surveying of the shores.

The mode of determining the direction of the currents was described in the chapter on the selection of cross-sections.

Having such an accurate plan of the river, it is now possible to define exactly the site of the crossing—viz., the axis of the designed bridge, according to the above-mentioned rules as follows:

1. The axis of the bridge should be as nearly as possible perpendicular to the direction of the high-water current.

2. The direction of the high-water current should, if possible, coincide with the low-water current; and when this condition cannot be satisfied, the center of the clear span should coincide with the chief current of the high-water, and the low-water current should pass in the middle of one of the spans.

CROSS-SECTION OF THE RIVER-BED AND SHORES.

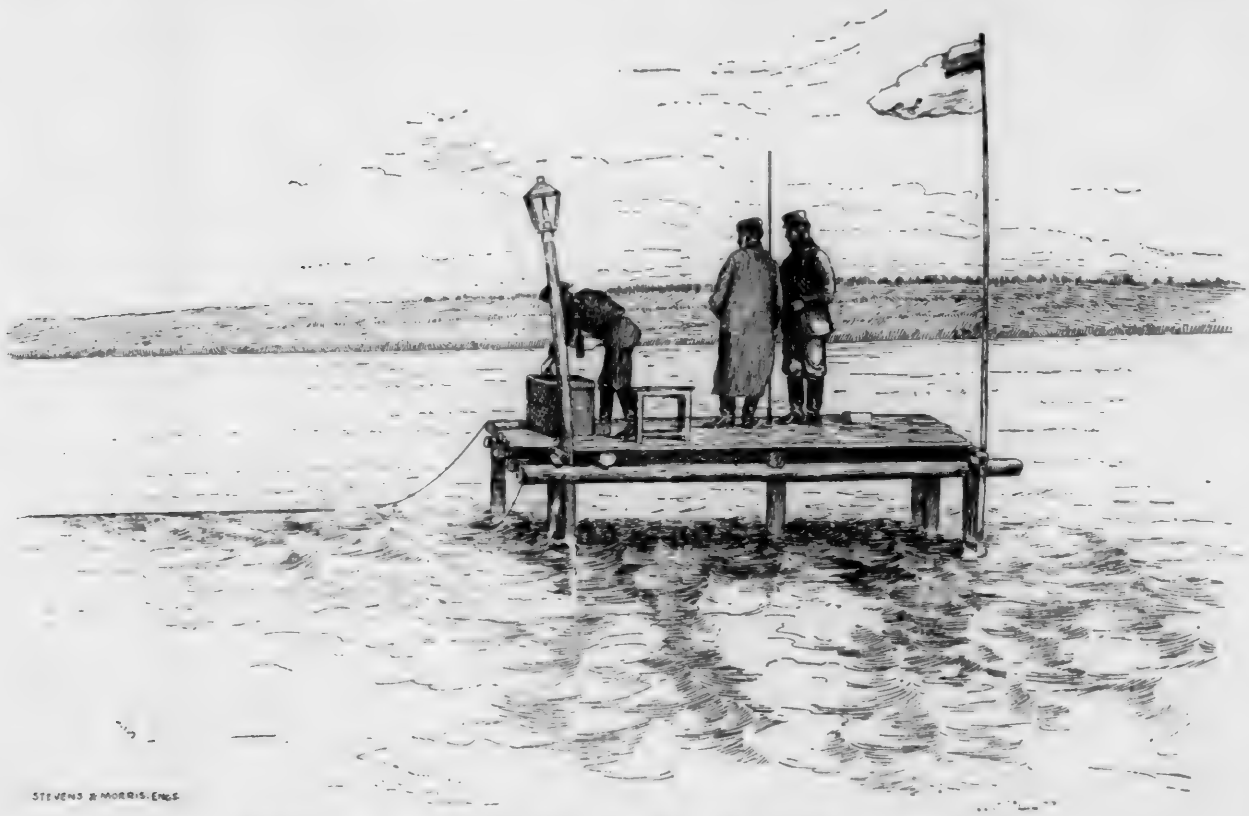
A profile of the cross-section along the line of crossing—the axis of the bridge—should be taken by means of soundings of the river-bed and leveling the shores. This profile should contain all the levels of water—the lowest, the highest, and the levels of spring and autumn ice running.

The same profile should show the kind of soil of the bed, and especially the depth at which the solid ground—rock, solid clay, etc.—is to be found. This information should be got by means of borings made on the shores and in the river-bed to the depth where the solid ground is found, and generally no more than 75 or 100 ft. below the low-water level. The borings should be made in the spots where the piers are expected to be, and generally at intervals of 300 to 500 ft. For these borings it is advisable to use a small portable drilling apparatus, making holes from 1¾ in. to 2¼ in. in diameter. Most excellent apparatus of this kind are made by Wolslav in St. Petersburg, and by the F. C. Austin Manufacturing Company in Chicago.

The illustration given is from a photograph of a party engaged in making borings in the bed of the Irtish River in Siberia at the point chosen for the crossing of the Siberian Railroad.

Analogous profiles should be made of the normal portions of the river selected for the determination of discharge; but it will not be necessary to make borings at those points.

(TO BE CONTINUED.)



BORING IN THE BED OF THE IRTISH RIVER IN SIBERIA.

BUILDING AN UNDERGROUND RAILROAD.

The Glasgow Central Railroad is a city line, chiefly underground, which is now under construction through the city of Glasgow, in Scotland, from the Dalmarnock Viaduct, on the Caledonian Railroad, to a double terminus at Maryhill and Dawsholm, on the opposite side of the city. The total length is 6¼ miles, of which about 5¾ miles are in tunnel, the rest in open cutting.

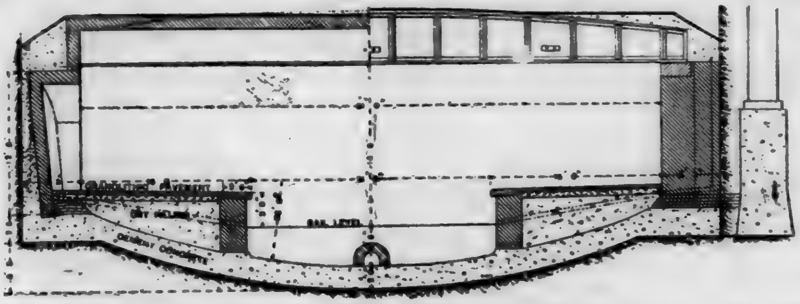


Fig. 3.—Transverse Section of Covered Way for Central Station, Trongate Section

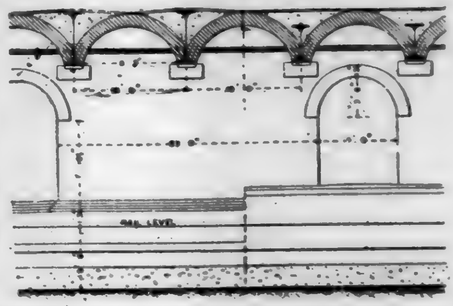


Fig. 4.—Longitudinal Section of Covered Way for Central Station.

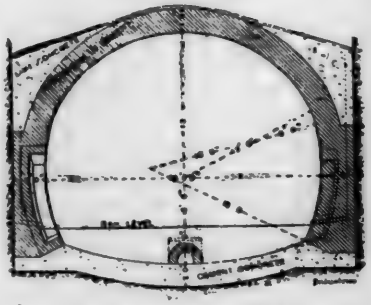


Fig. 5.—Transverse Section of Covered Way No 1

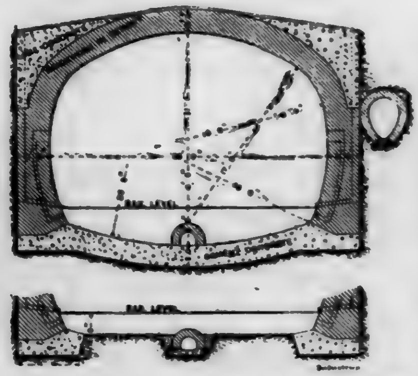


Fig. 6.—Transverse Section of Covered Ways Nos. 1 and 2, with and without Invert.

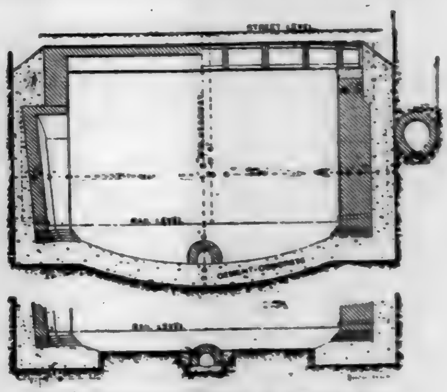


Fig. 7.—Transverse Section of Covered Way No. 8, with and without Invert.

THE GLASGOW CENTRAL RAILWAY TUNNEL, GLASGOW, SCOTLAND.

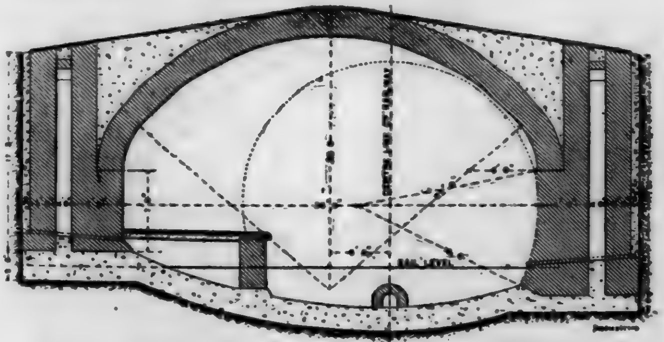


Fig. 2.—Transverse Section of Covered Way No. 7, Bridgeton Section.

The sections adopted for the tunnel vary considerably, according to the depth below the surface. At some points an ordinary cylindrical arch is used; at others a flatter arch, and at others again the line is so near the surface that the street is supported by girders. The accompanying drawings, for which we are indebted to *Industries*, show sections of the tunnel at different points. Figs. 2, 3 and 8 are taken at points where there are stations, and the tunnel is widened out to take in the platforms.

The method adopted for working under the streets of the city where the tunnel passes seems to be a very good one. Rows of piles are first driven on either side by an overhead traveler, spanning the entire roadway and permitting vehicular traffic to pass beneath it. The platform of the traveler carries pile drivers, boilers, etc., and piling is performed on either side. The legs of the traveler are carried on rails, and when one length of the street is finished the traveler is moved on. The next operation consists in taking up the roadway and substituting timbering to carry the traffic; such timbering being supported by the piles already driven. Tunneling then proceeds beneath the timbered street, and were it not for the manholes here and there, through which soil is being brought up or material lowered down, few persons would be aware of the work carried on only some few inches beneath their feet. The ordinary operations of tunneling are carried out as follows: In advance a gang of men are excavating by hand, the side walls are built up to follow, and the arching on timber centring completes the work. The timbering forming the street is then removed, and the vacant spaces made up to street level. In this manner length by length of the work is rapidly proceeding without any hindrance whatever to the ordinary vehicular traffic.

As in all city structures of this kind, the greatest difficulties are found in crossing the sewers which are intersected by the tunnel. Some of these are of large size, and are important factors in the drainage of the city. The general plan adopted has been to carry the sewers under the tunnel, providing ample accommodation for an increase in size should it be required hereafter. At several points also careful work was needed to avoid injury to the foundations of buildings.

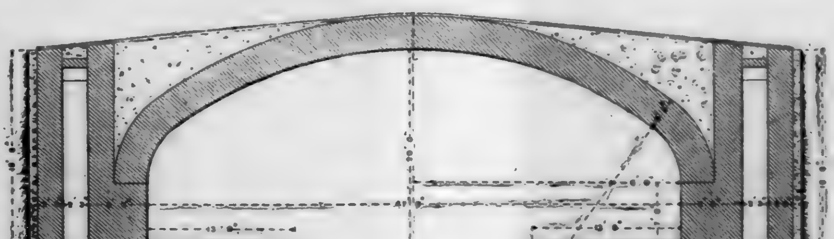
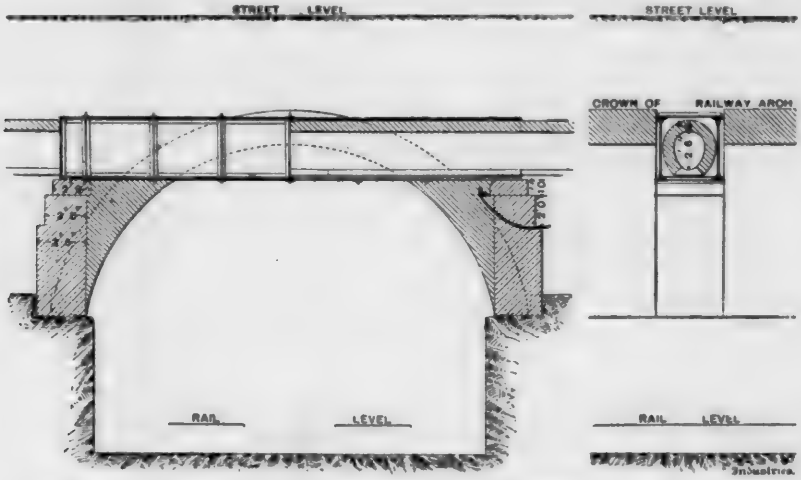


Fig. 8.—Transverse Section of Covered Way No. 6, Bridgeton Section

Some other difficulties were met with, chiefly owing to the fact that portions of the tunnel are built through fine sand, and are below the water level in this sand, so that much care was required in excavating and lining. But little rock-work has been required.

Figs. 9, 10 and 11 show one method of carrying a sewer over the tunnel, which was adopted at one street crossing. This consisted, as will be seen from the drawings, in the use of steel-plate girders resting on an abutment at each side, the girders coming a little below the crown of the tunnel arch. A floor supported by these girders carries the sewer, which is thus taken across the top of the tunnel without any break in its continuity.



FIGS. 9 AND 10.—SECTIONAL VIEWS OF TUNNEL AT DUMBARTON ROAD, SHOWING CROSSING OF SEWER.

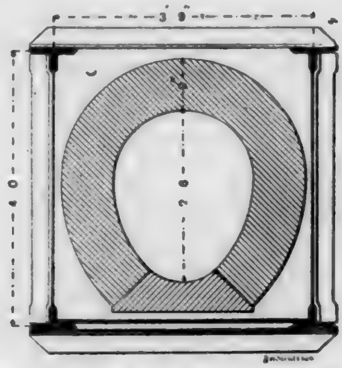


FIG. 11.—TRANSVERSE SECTION OF STEELWORK CARRYING SEWER UNDER DUMBARTON ROAD

PROGRESS IN FLYING MACHINES.

By O. CHANUTE, C.E.

(Continued from page 372.)

IN 1863 M. *de Louvrié*, a French engineer and mathematician, proposed the apparatus shown in fig. 43, which he called an "aeroscaphe." It consisted in a kite-like surface, stiffened by light cords to a mast above and to the car below, and capable of acting as a parachute, as well as of being folded like the wings of a bird. It was intended to progress through the air either through the agency of a screw driven by a motor, or more directly by the reaction upon the air of some explosive substance, such as gunpowder. It was submitted to the French Academy of Sciences, but no experiments were made on a practical scale.

FIG. 43.—DE LOUVRIÉ—1863.

This proposal was the result of a mathematical investigation of the action of air upon aeroplanes and under the wings of birds, which was published by M. *de Louvrié*, first in *Les Mondes* and then in the *Aéronaute*,* wherein he showed that *Navier* and other French mathematicians had grossly overestimated the power required for flight. He also contended that the formulas then in current use for calculating the reactions of air upon oblique surfaces were erroneous, and he advanced the empirical formula of *Duchemin*, hereinbefore given, as agreeing much more closely with the observed facts. These writings of M. *de Louvrié* were sharply attacked by other aviators,† who had been promoting the imitation of flapping wings, and who denied altogether the possibility of soaring or sailing flight of birds, so that a lively controversy ensued, which has continued to this day, for M. *de Louvrié* published in 1890* a new formula on a rational basis, of fluid action upon oblique surfaces, which agrees very closely in its results with those of the *Duchemin* formula, and he has also written an article on the "Theory of Sailing Flight," which is to appear shortly.

The "aeroscaphe" was practically a kite without string or tail, and its stability would probably have been found deficient, but M. *de Louvrié* tried in 1866 some experiments with a model weighing some 9 lbs. and exposing a surface of about 11 sq. ft. This ran upon a car on an inclined plane, and the "lift" and the "drift" were carefully measured by means of dynamometers. The results of these experiments demonstrated the fact that at all velocities and for all angles the "drift" or resistance of a plane to motion is to the "lift" or supporting pressure as the *sine* of the angle of incidence to its *cosine*; as indeed was to be expected from theoretical considerations, and as had been laid down in 1809 by Sir George Cayley, in the article which has already been herein quoted.

As the *sine* is to the *cosine*, as the *tangent* of the angle M. *de Louvrié* deduced from his experiments the fundamental formula for the resistance of aeroplanes to be

$$R = W \text{ tang. } @,$$

in which R is the resistance or "drift," W the weight, and @ the angle of incidence; and calling L the "lift" and P' the normal pressure, at that angle of incidence, we may write further:

$$R = W \text{ tang. } @ = P' \text{ sin. } a$$
$$L = W \qquad\quad = P' \text{ cos. } a,$$

which formulas furnish at once the "drift" and the "lift" when either the normal pressure or the weight is known. In 1868 M. *de Louvrié* took out a second French patent for an aeroplane, in which he chiefly described the method of stretching the kite sail by adjustable radiating arms. It was to have a flat diedral angle to provide stability sideways, and was to be driven by a hot air engine, but no experiments seem to have been made. Since then he is understood to have abandoned the promotion of aeroplanes, and to expect more favorable results from his "anthropornis," which has already been noticed under the head of "wings and parachutes."

It may be incidentally here mentioned that a somewhat similar proposal for a circular kite or flat parachute was patented in the United States by Mr. *Wooton* in 1866. It must have been found, if experimented with, quite deficient in stable equilibrium; any square, round, or polygonal surface being quite inferior in stability to the comparatively long and narrow wings which form the sustaining aeroplanes of the birds.

While it seems certain, from the shape and arrangement of the apparatus of *Carlingford*, *Du Temple* and *De Louvrié*, that they had in mind the possibility of soaring upon the wind like a bird, they all proposed some kind of an artificial motor, and none of them was bold enough,

* *L'Aéronaute*, September, October and November, 1868.
† *Ibid.*, December, 1868; January and February, 1869.

* *Revue de l'Aéronautique*, Vol. 3, page 102.

in the face of existing prejudice, to propose to trust to the wind alone as a motive power. This was reserved for Count *D'Esterno*, who published in 1864 a very remarkable pamphlet* upon the evolutions and flight of birds, in which he gave the results of his many years of close observation, and formulated what he considered to be "the seven laws of flapping flight and the eight laws of soaring flight." He held that the act of flight involved the providing for three distinct and indispensable requirements—*i.e., equilibrium, guidance* and *impulsion*, and that the latter could be obtained from the wind whenever it blew strongly enough. He says in his pamphlet:

"Sailing flight labors under the disadvantage that it cannot take place without wind; but, on the other hand, we can derive from the wind, when it blows, an unlimited power, and thus dispense with any artificial motor. In sailing (or soaring) flight, a man can handle an apparatus to carry 10 tons, just as well as one only carrying his own weight. Whoever has seen large birds of prey sailing upon the wind, knows that without one flap of their wings they direct themselves as they choose, save when they want to go dead with the wind or dead against it, on which occasions they must either tack or sweep in circles."

He patented in 1864 the apparatus shown in fig. 44, consisting of two wings hinged to a frame at the side of a central car, so that they could be set at any diedral angle, or even

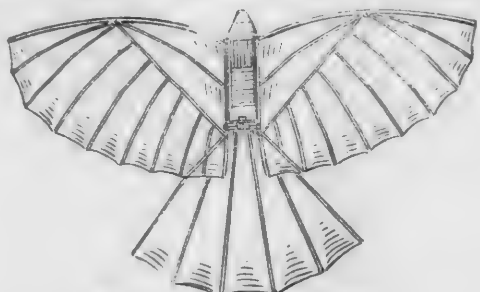


FIG. 44.—D'ESTERNO—1864.

flapped should a motor be applied. The front end of the frame was provided with trunnions fitting in sockets inserted in the car, so that the rear end of the wings could be raised or lowered, thus altering the angle of incidence, and incidentally moving the wings forward or backward with respect to the car. The wings themselves were to be rigid within the triangles next to the car, and made flexible in the rearward portion, where the curved ribs are shown, which latter might be made of whalebone. It was claimed that these wings would thus be capable of three movements, corresponding to the first three "laws" laid down by *D'Esterno*: 1. An up-and-down or flapping action; 2. A forward or backward inclination, and 3. A torsional or twisting motion. The tail was connected with the car with a universal joint, and had also three motions corresponding to the next three laws—viz.: 4. An up-and-down oscillation; 5. A lateral displacement sideways, and 6. Torsion. The car was provided with a movable seat, and the operator could either sit thereon, and shift his weight forward and back or sideways, or he might stand up and effect the same object by swaying his body or moving about, this action displacing the center of gravity of the apparatus, and corresponding to the seventh law of flapping flight, or means for the maintenance of equilibrium; to which for sailing flight *D'Esterno* added still an eighth requirement or "law" in affirming the necessity for an initial headway.

He indicates in his book that an apparatus for one man would weigh, with the operator, approximately 330 lbs., and spread an equal number of square feet of horizontal surface, 215 sq. ft. of which would be in the two wings, each being approximately 15½ ft. long by 7 ft. wide, and he describes in his patent, mechanism somewhat crude, chiefly consisting of ropes and drums, for producing the various motions described.

The proposed mode of actual operation is not described, but it must have been nearly identical with the evolutions of the sparrow-hawk in the excursion which has been described. The apparatus would first descend in order to obtain an initial velocity, after which, having a speed of its own, it might utilize that of the wind. During this descent the fore-and-aft plane of the wings would have to point below the horizon, and if the reader will refer to the various attitudes of the sparrow-hawk on fig. 36, he will note that between points *A* and *B* his wings were scarcely open, in order to diminish the "drift." Once the speed gained, the apparatus would needs alter its center of gravity in order to change upward the angle of incidence and to come on a nearly level keel. If it went dead with the wind, its relative speed would have to be great enough to furnish support; if going dead against the wind, it would lose headway but gain elevation; and it might tack on a quartering wind or describe a series of helical orbits, like those of the birds. If the latter were chosen, the apparatus would, when it had the wind in its quarter, be sailing into the "eye of the wind" and faster than it blew, just as in the case of the ice boat; while it would probably need to descend a little on the part of the circle when it was going with the wind, and would be enabled to rise materially when, upon facing the wind, the force of the latter was added to its own initial velocity. Thus, at every turn height would be gained, this being acquired when going against the wind; and height once obtained, the apparatus would be able to sail in any direction by descending.

It will be noted, however, how many delicate manœuvres are requisite to accomplish these evolutions: to alter the angle of incidence, the direction, the speed, and to maintain the equilibrium at all times. The bird does all this by instinct; he performs the exact manœuver required accurately, at exactly the right time, and he is always master of his apparatus; but the man would be at a terrible disadvantage, his perceptions and his operations would be too slow, and a single false movement might be fatal.

There probably would have been many mishaps at first with Count *D'Esterno's* apparatus had it been experimented, and being aware of this difficulty, he proposed that the experiments should be conducted over water sufficiently deep to break the fall, the apparatus being raised, like a kite, by a cord fastened ashore, which the operator could hold fast or abandon at will, while he was acquiring the science of the birds.

At that time (1864) aviation was not in public favor, and the very existence of soaring or sailing flight of birds was strenuously denied. It was held that there must be some small movements of the wings, which sustained the bird in the air, and which the observers had failed to detect, and it was not till the subsequent observations of *Pénaud, Wenham, Basté, Peal, Darwin, Mouillard*, and others that it was admitted that a bird might sail by the sole force of the wind without flapping.

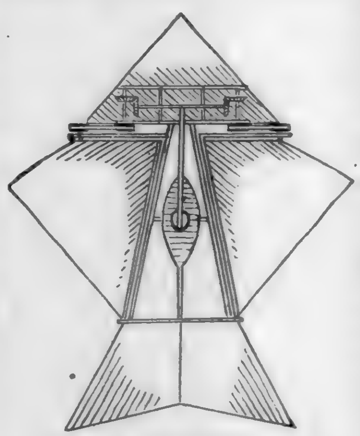


FIG. 45.—CLAUDEL—1864.

Count *D'Esterno's* proposal was generally laughed at as an evidence of mild lunacy, and whether because of this reason or because he distrusted the efficacy of his own mechanism, he did not build his apparatus. This is the more to be regretted because, being in possession of an ample fortune, he might have tried a number of valuable experiments which, if they did not result in success (as they probably would not), might yet have greatly advanced the fund of knowledge upon this intricate subject. Later on, when aviation grew in favor, and he was urged by members of the French Aeronautical Society, he conferred with various ingenious mechanics, and in 1883 he made an arrangement with M. *Jobert* to build a soaring apparatus. This was well under way when, in that same year, Count *D'Esterno* died at the age of 77. The apparatus was never com-

* "Du Vol des Oiseaux," D'Esterno, 1864.

pleted, and, such as it is, has been deposited in the Exposition Aéronautique.

A singular proposal was that of M. *Claudel*, who patented in 1864 the apparatus shown in fig. 45. This consisted of two aeroplanes, one at the front and one back, propelled by two wings, lozenge-shaped, and rotated upon pivots at each apex. If they were made flexible the resistance of the air would bend these wings into an elongated screw, and some propelling effect might be produced. They were to be driven by bevel gears set in motion by a steam engine in the car; but it is not known whether any practical experiments were ever tried.

In 1866 Mr. *F. H. Wenham* patented the meritorious proposal of superposing planes or surfaces above each other, so as to increase the supporting area without increasing the leverage. These were to be "kept in parallel planes by means of cords, or rods, or webs of woven fabric. . . . The long edges of the surface," made of silk or other light material, to be placed "foremost in the direction of motion." This system of surfaces being arranged above a "suitable structure for containing the motive power." If manual power was employed, the body of the operator was to be placed in a *horizontal* direction, and "the arms or legs to work a slide or treadle from which the connecting cords convey a reciprocating motion to oars or propellers, which are hinged above the back of the person working them."

In a very able paper, which has become classical, read at the first meeting of the Aeronautical Society of Great Britain, in 1866, Mr. *Wenham* gave an account of his observations, concluding with a very valuable discussion of the problem of flight, and with the following description of his experiments:

Having remarked how thin a stratum of air is displaced beneath the wings of a bird in rapid flight, it follows that in order to obtain the necessary *length* of plane for supporting heavy weights, the surfaces may be superposed or placed in parallel rows, with an interval between them. A dozen pelicans may fly, one above the other, without mutual impediment, as if framed together; and it is thus shown how two hundred weight may be supported in a transverse distance of only 10 ft.

In order to test this idea, six bands of stiff paper 3 ft. long and 3 in. wide were stretched at a slight upward angle in a light rectangular frame, with an interval of 3 in. between them, the arrangement resembling an open Venetian blind. When this was held against a breeze, the lifting power was very great; and even by running with it in a calm it required much force to keep it down. The success of this model led to the construction of one of a sufficient size to carry the weight of a man. Fig. 46 represents the arrangement, being an end eleva-

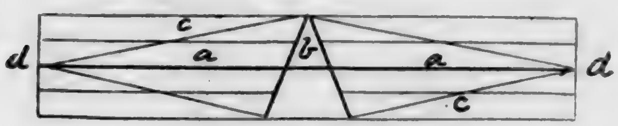


Fig. 46.—WENHAM—1866.

tion; *a a* is a thin plank tapered at the outer ends, and attached at the base to a triangle, *b*, made of similar plank for the insertion of the body. The boards *a a* were trussed with thin bands of iron *c c*, and at the ends were vertical rods *d d*. Between these were stretched five bands of holland 15 in. broad and 16 ft. long, the total length of the web being 80 ft. (100 sq. ft. of surface). This was taken out after dark into a wet piece of meadowland one November evening, during a strong breeze, wherein it became quite unmanageable. The wind acting upon the already tightly stretched webs, their united pull caused the central boards to bend considerably, with a twisting, vibratory motion. During a lull, the head and shoulders were inserted in the triangle, with the chest resting on the base board. A sudden gust caught up the experimenter, who was carried some distance from the ground, and the affair, falling over sideways, broke up the right-hand set of webs.

In all new machines we gain experience by repeated failures, which frequently form the stepping-stones to ultimate success. The rude contrivance just described (which was but the work of a few hours) had taught, first, that the webs or aeroplanes must not be distended in a frame, as this must of necessity be strong and heavy to withstand their combined tension; second, that the planes must be made so as either to furl or fold up for the sake of portability.

In order to meet these conditions, the following arrangement was afterward tried: *a a*, fig. 47, is the main spar, 16 ft. long, ½ in. thick at the base, and tapered, both in breadth and thickness, to the end; to this spar was fastened the panels *b b*, having a base board for the support of the body. Under this, and fastened to the end of the main spar, is a thin steel tie band, *e e*, with struts starting from the spar. This served as the foundation of the superposed aeroplanes, and, though very

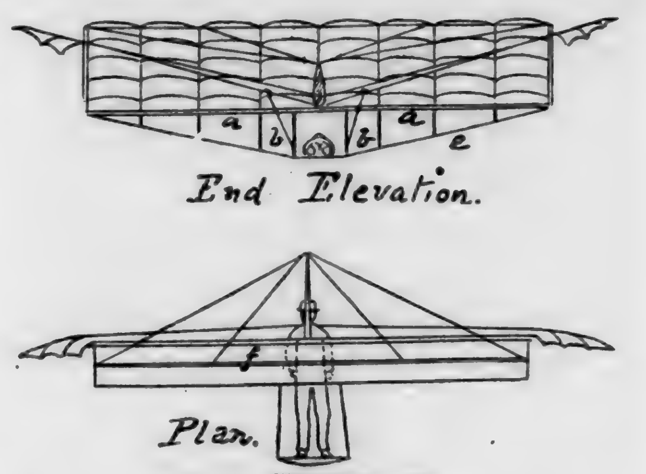


Fig. 47.—WENHAM—1866.

light, was found to be exceedingly strong; for when the ends of the spar were placed upon supports, the middle bore the weight of the body without any strain or deflection; and further, by a separation at the base-board, the spars could be folded back with a hinge to half their length. Above this were arranged the aeroplanes, consisting of six webs of thin holland 15 in. broad (giving 120 sq. ft. of supporting surface); these were kept in parallel planes by vertical divisions 2 ft. wide of the same fabric, so that when distended by a current of air, each two feet of web pulled in opposition to its neighbor; and finally, at the ends (which were sewn over laths), a pull due to only 2 ft. had to be counteracted, instead of the strain arising from the entire length, as in the former experiment. The end pull was sustained by vertical rods, sliding through loops on the transverse ones at the ends of the webs, the whole of which could fall flat on the spar till raised and distended by a breeze. The top was stretched by a lath, *f*, and the system kept vertical by stay-cords taken from a bowsprit carried out in front. All the front edges of the aeroplanes were stiffened by bands of crinoline steel. This series was for the supporting arrangement, being equivalent to a length of wing of 96 ft. Exterior to this two propellers were to be attached, turning on spindles just above the back. They are kept drawn up by a light spring, and pulled down by cords or chains running over pulleys in the panels *b b*, and fastened to the end of a swiveling cross-yoke sliding on the base-board. By working this cross-piece with the feet, motion will be communicated to the propellers, and by giving a longer stroke with one foot than the other, a greater extent of motion will be given to the corresponding propeller, thus enabling the machine to turn, just as oars are worked in a rowing boat. The propellers act on the same principle as the winds of a bird or bat; their ends being made of fabric stretched by elastic ribs, a simple waving motion up and down will give a strong forward impulse. In order to start, the legs are lowered beneath the base-board, and the experimenter must run against the wind.

An experiment recently made with this apparatus developed a cause of failure. The angle required for producing the requisite supporting power was found to be so small that the crinoline steel would not keep the front edges in tension. Some of them were borne downward, and more on one side than the other, by the operation of the wind, and this also produced a strong fluttering motion in the webs, destroying the integrity of their plane surfaces, and fatal to their proper action.

Another arrangement has since been constructed having laths sewn in both edges of the webs, which are kept permanently distended by cross stretchers. All these planes are hinged to a vertical central board, so as to fold back when the bottom ties are released, but the system is much heavier than the former one, and no experiments of any consequence have yet been tried with it.

It may be remarked that although a principle is here defined, yet considerable difficulty is experienced in carrying the theory into practice. When the wind approaches to 15 or 20 miles per hour, the lifting power of these arrangements is all that is requisite, and, by additional planes, can be increased to any extent; but the capricious nature of the ground-currents is a perpetual source of trouble.

If Mr. *Wenham* tried any further experiments with his apparatus, he has not, to the writer's knowledge, published an account of the results. They would be nearly certain to be unsatisfactory for want of stable equilibrium. The *Wenham* aeroplane was even more unstable than that of the bird, and the latter is constantly in need of adjustment, to counteract the "ground currents" and the variations in speed and in the angle of incidence. Moreover, the *horizontal* position selected by Mr. *Wenham* was most unfavorable because unnatural to man, in directing the movements of an apparatus; so that as often as he might rise upon the wind, just so often he was sure to lose his balance and to come down with more or less violence. The two propellers described by him would of course have proved quite ineffective in sustaining the weight, because man's muscular power is quite insufficient to have worked them with a speed adequate to that purpose, but they might have served to direct the course, had the equilibrium of the apparatus been stable.

Indeed, the writer believes that the first care of the aviator who seeks to solve the problem of flight, must be to seek for some form of apparatus which shall be, if possible, more stable in equilibrium than the bird. The latter is instinct with life; he meets an emergency instantly. Man's apparatus will be inanimate, and should possess automatic stability. Safety is the first requisite—safety in starting, in sailing, and in alighting, and the latter operation must be feasible almost everywhere without special preparation or appliances before the problem can be said to be fairly solved. It will probably prove the most difficult detail to accomplish, but it does not seem impossible when we see the feat performed by the birds so many times every day.

Mr. *Wenham's* proposal to superpose planes to each other in order to obtain large supporting surfaces without increasing the leverage, and consequent weight of frame, will probably be found hereafter to be of great value. The French experimenter *Thibaut* found that when two equal surfaces were placed *one behind the other*, in the direction of fluid motion, the resistance more nearly equaled that of the two separate surfaces than might be supposed. Thus for two square planes, placed at a distance apart equal to their parallel sides, so as to cover each other exactly, M. *Thibaut* found the resistance equal to 1.7 times that of one single surface. When the hinder plane projected by 0.4 of its surface beyond the front plane, the resistance was 1.95 times that of the single surface. This diminished to 1.84 times, when it became 0.9. Beyond this it reached nearly twice the resistance.*

Professor *Langley* found in his experiments with superposed planes, 15×4 in., soaring at horizontal speed, that "when the double pairs of planes are placed 4 in. apart or more, they do not interfere with each other, and the sustaining power is, therefore, sensibly double that of the single pair of planes; but when placed 2 in. apart, there is a very perceptible diminution of sustaining power shown in the higher velocity required for support and in the greater rapidity of fall." †

We may hence conclude that there will result a material, indeed a great advantage in superposing planes, provided they are so spaced as not materially to interfere with each other, and provided also that they are arranged so as to afford a good equilibrium.

(TO BE CONTINUED.)

ELECTRIC SAFETY SIGNALS.

THE London *Times* comments as follows on the electric signal devices shown at the Electric Exhibition now in progress in London:

Unquestionably the exhibits of the trial appliances for the better securing of safety to railroad trains are of leading importance, and, as a whole, merit something more than a mere passing record. They illustrate one of the most anxious and difficult problems railroad officials have to deal with, and they afford evidence of the great amount of skill and ingenuity that have been expended on the subject. It is, however, a matter for grave reflection that, in spite of all the precautions taken and of the perfection attained in this connection, it is, after all, open to human fallibility to step in and pave the way to accident, as we shall show. Technically the contrivances exhibited are known as effecting electrical interlocking, to be used in addition to what may be described as the ordinary mechanical system of interlocking points and signals. The combination has been—not inaptly—designated as a union of the lock and block systems. Both of these systems separately are required by Act of Parliament to be provided on all the railroads of the United Kingdom, but up to the present time it is not a Board of Trade requisition that they shall be used in combination. Nevertheless, such combined action and interdependent working of the lock and block systems is recognized by practical railroad men as adding greatly to the safe working of railroads, and it is now being adopted on some of the leading lines. The absolute block system is of itself most excellent, and but for the element of human fallibility in working, it would be almost absolutely reliable. That element, however, has to be dealt with. For instance, signal-man A telegraphs to signal-man B that the line is blocked. B misinterprets or disregards the message, and inadvertently lowers the out-door signal and permits a train to pass into a section of the line which is blocked or not cleared by a previous train, and an accident, or a great risk of one, is the result. To obviate this danger an electric lock is applied to the hand levers of the out-door signals, so that either signal-man A or B, when he receives a telegraphic indication that the line is blocked, is prevented from moving his hand lever to give a signal which would be contrary to such indication. In one of the modern safety appliances exhibited, the electric lock acts upon the out-door signal itself instead of upon the hand lever in the signal-man's cabin; and this is doubtless, in certain respects, an improvement. But there is a step in advance of this in another appliance, which appears to afford the greatest security against human fallibility. This is the treadle arrangement, which is placed on the line, and which gives automatic control of the out-door signal to the train itself. This, however, does not in any way interfere with or lessen the responsibility of the signal-man. It is only supplementary; but if either or both the signal-men simultaneously should make a mistake by omitting to put a signal to danger, or by attempting prematurely to exhibit a safety signal, the train itself so acts upon the signal through the treadle arrangement that any irregular act of the signal-man, either of omission or commission, is counteracted and rendered harmless.

ELECTRICITY ON RAILROADS.

(From *Industry*, San Francisco.)

THERE is just now going on a good deal of talking and writing respecting the use of electric motors on standard railroads, especially for urban traffic, and there are a good many reasons why the system is preferable to steam locomotives, but in most cases those writing and speaking of the matter call it electricity superseding steam power.

Any innovation of the kind will be sooner understood and adopted if people would stop talking of "electric motive power." An electric motor on a locomotive represents the boiler and engines, which we may say, are taken from the engine and placed in a station, from which the power is sent out to the engine through the motor. In this manner, it is a problem admitting of generalization to a great extent and does not work out at all, as is popularly imagined. For example, one hears that we will soon have electric locomotives, and the tons of dead weight now carried can be dispensed with. This is another mistake. The tons of dead weight are an essential part of a locomotive, performing an indispensable function, and if the steam power is removed, an equivalent weight of something else must be added.

There enters also into the problem a principle in mechanics which is sometimes called inter-dependence, and a very important one in this case. An automobile machine,

* Derval, "Navigation aerienne," 1889, p. 185.
† Langley, "Experiments in Aerodynamics," p. 40.

FIRST-CLASS BATTLE-SHIP "ROYAL SOVEREIGN," FOR THE ENGLISH NAVY.

like a steam locomotive, is independent within itself, and not dependent on other engines. The disablement of one engine extends no farther, and need not disturb the traffic of a road beyond the train it is drawing; but if the power is centralized or distributed from a station, then the whole traffic of a line depends upon the maintenance of the generating plan.

A cable railroad or an electric one, compared with a steam or horse-car route, illustrates the matter. When the cable or the current stops the whole traffic is suspended, but the traffic drawn by horses or steam goes on without liability to such detention. On the other hand, we have the inefficiency of the horse system, the danger, smoke and heat of the steam one, so the final end, or "survival of the fittest," must be left to time and evolution, despite the prophecy of those who proclaim the substitution of steam with what they call "electrical power." Wholesale predictions of sweeping change, as said in the beginning, only discourage and hinder progress in the advancement of electrical methods that are now giving promise of wide application in what we call standard devices.

THE LARGEST BATTLE SHIP.

The illustration given herewith, which is reduced from a very handsome engraving in the London *Engineer*, shows the new battle-ship *Royal Sovereign*, which is one of the largest—if not the largest—fighting ships yet built.

The *Royal Sovereign* is 380 ft. long, 75 ft. beam, has a mean draft of 27 ft. 6 in. and a displacement of 14,260 tons. She has an armor belt 18 in. thick and 250 ft. long, and a protective deck 3 in. thick, besides heavy armor protection for the guns in the central barbette. She has twin screws, each driven by a triple-expansion engine with cylinders 40 in., 59 in. and 88 in. in diameter. On trial these engines have developed 9,400 H.P. with natural draft and 14,000 H.P. with forced draft, the respective speeds reported being 16.77 and 18 knots. The ordinary coal capacity is 900 tons, giving a cruising radius of 5,000 knots at a 10-knot speed.

The armament consists of four 67-ton, 13½-in. guns mounted in pairs in the barbette; ten 6-in. rapid-fire guns; sixteen 6-pdr. and nine 3-pdr. rapid-fire guns; eight small machine guns; two 9-pdr. field guns; seven torpedo-tubes, three of which are submerged. The 67-ton guns are 23 ft. above the water, the ship having about 19 ft. freeboard; they carry a projectile weighing 1,250 lbs., with a powder charge of 630 lbs. These guns can be given about 13° elevation and 5° depression, and have an arc of fire of 240°; they are worked by hydraulic gear. The torpedo-tubes will carry an 18-in. torpedo.

The ship has electric light apparatus and all the latest improvements in ventilation, etc.; it is stated that the accommodations for officers and crew are better than in most modern battle-ships.

On the speed trials, in an eight-hour trial an average of 16.77 knots an hour was reached with natural draft. With forced draft 18 knots were made, but this trial was cut short in the fourth hour, serious leaks having developed in a number of the boiler tubes. The forced draft trial is to be repeated when the necessary repairs to the boilers have been made.

The *Royal Sovereign* is a very formidable ship, and she is also a much more manageable vessel than some of the other English battle-ships, which have hardly been a success in manœuvering. Her appearance, as shown by the cut, is certainly very handsome.

THE FUTURE DEVELOPMENT OF ELECTRIC RAILROADS.

(From the address of President Frank J. Sprague, at the Chicago meeting of the American Institute of Electrical Engineers.)

Among the roads which are ripe for the electrical engineer, and on which, in the near future, I hope he will demonstrate he has a most legitimate claim, are the New York Elevated and the Chicago Elevated, the handling of the trains on the New York Central and Harlem roads below the Harlem River, the long-talked-of rapid transit road of New York, the Metropolitan Underground road of London, the proposed tunnel roads in London, Paris, and Berlin, and, coming more immediately home, suburban service, such as that of the Illinois Central Railroad—a most ideal track for the electrical engineer; and last, and as it will prove, one of the most important, the operation of terminal and warehouse systems for the interchange of freight on the lines entering a city situated like Chicago.

Taking this last, we have here a definite problem, now performed in a more or less satisfactory way by steam service. It is a problem large enough of itself. It has little connection with electric trunk-line service, and the present impracticability of the latter has little bearing upon the thorough practicability of the former. Eighteen hundred, or more, switch engines, many of them on duty twenty-four hours a day, a large portion of the time standing idle, puff their foulness into your overburdened atmosphere, because from 80 to 90 per cent. of all the freight that comes into the depots of this city ought never come inside its limits, and would not, were there a practical way provided to distribute it from one railroad to another outside the city limits. It has been suggested, and it seems to me a most feasible plan, that there shall be established a vast system for interchanging freight on the various railroads by a great six-track crossing belt road, which shall form a common zone of transfer either by itself or in combination with freight warehouses or storage yards. Undoubtedly there are many difficulties in the way, but from an electrical standpoint there is absolutely no question but that such a system of belt line is practicable.

With such unsolved problems, such abundant fields, I deem it unnecessary now to attempt to build electric locomotives to pull trains of great weight 100 miles an hour, or to develop a system of conductors for trunk-line service which is not possible for yard duty, or to consider a central station or track equipment for a duty never required. This problem is in a measure an experimental one, which, being carried to a certain measure of success, will clearly point the way for future development and outline its limits.

I may be pardoned, perhaps, if I take radical views in some matters of railroad practice. I have fortunately, or otherwise, been thrown into direct touch with all the larger work which is to be done in this country during the coming year, and it gives me pleasure to announce what many of you know from the current news of the day that there will probably be in operation in the United States within 12 months not less than five locomotives varying from 700 to 1,200 H.P. and from 45 to 80 tons in weight. The character of the work done will vary. In that work which I am most concerned with from a personal standpoint, a 700-H.P. electric locomotive will be built for experimental work, and to attempt to solve, as far as may be, the various problems which are involved in railroad practice in Chicago. If my judgment is followed, there will be an experimental section of track in the form of a loop about 13 miles long, with 18 miles of rail, and with every variety of single and double track construction and simple and compound crossings and switches.

On this I hope to see erected such varieties of overhead construction as may be found best to meet the various kinds of service, and where the railroad problems on track jointly operated by steam and electricity can be developed in the most satisfactory manner. On this track there will be not only this locomotive but also one of equal rated capacity supplied by one of the larger manufacturing companies.

The duty demanded of these machines will be severe. They will be required to haul a train of not less than 450 tons at 30 miles an hour up a grade of 26 ft to a mile. They will probably be required to develop their full rate of capacity at all speeds between 30 and 60 miles per hour, and if there is sufficient track-room they will be driven at speeds of at least 75 and perhaps 100 miles per hour for short distances. The potentials used will be nearly double that at present obtained in street railroad practice.

A still larger problem, so far as power goes, although not in the variety of conditions which will have to be met, will be that recently taken for the operation of the Belt

Line tunnel now being constructed in Baltimore to avoid the necessity of boat transfer at Locust Point. The duty of the motor here will be to propel the train with engines coupled on but not in operation through a tunnel about 6,000 ft. long. The conditions require motors which will weigh about 80 tons, and have a capacity of about 1,200 H.P. to propel a 1,200-ton freight train up a grade of 42 ft. to the mile at a speed of 15 miles per hour. Passenger trains of 450 tons' weight must be regularly started from rest twice in the tunnel on this grade, and in an emergency the motors must start the freight train. The draw-bar pull under regular duty, and when not starting, may be as high as 32,000 lbs.

Perhaps the traffic from New York to Philadelphia affords as good an example as any of what may be done on regular passenger service, provided the track is clear enough. For this, I some three years ago, and again in the *Forum* of September, 1891, outlined an electric express service with a method of supply through a rod carried above the car and a return circuit through the rails and earth. The current was to be supplied from one or more central stations equipped with high-class triple-expansion engines driving multipolar dynamos directly coupled. What the electrical engineer and the railroad men as well needs to know is whether the electromotice force required on the line and the number of stations necessary would be prohibitory.

No attempt was made for an excessive speed, but I confined myself to the average speed of a mile a minute for a distance of 90 miles, and considered a through service only. I assume a total weight of copper of only about two-thirds that which exists on the long-distance telephone line between New York and Boston. The trains were to be two-car units leaving every ten minutes.

I found with these conditions the stations and potentials would be about as shown in the following table:

Stations.	Miles apart.	Potential.	
		Two-wire	Three-wire.
1	—	3,600	1,800
2	45	1,800	900
3	30	1,200	600
4	22½	900	450

If the three-wire system is used—that is, the rails as a compensating conductor between two trolley roads—then with only two stations 45 miles apart it is seen that the potential is less that 1,000 volts, and this we undoubtedly can handle.

I am not prepared to say that we may not use even a higher pressure, because I believe whatever is demanded in the interests of economy, all things being considered, will be used, but if we can reduce the potential to perfectly safe and reasonable limits by multiplying the number of stations, then those stations should be increased so long as the increase does not seriously affect the general expense of working. On a service of this character, where I have made the conditions, distributed work and the dispatching of units at brief intervals—which conditions, I repeat, are absolutely necessary if we are to consider long-distance transportation by electricity—such increase of stations as is advisable will not increase the cost of central station operation.

Such is the work before you—a work well meriting your best efforts, yet it is well to temper your enthusiasm with prudence. Limit your attempts to the solution of those problems which will prove of practical benefit. Remember that neither sentiment nor ignorance, but lessened costs of operation for equivalent duty and increased returns on invested capital are winning cards.

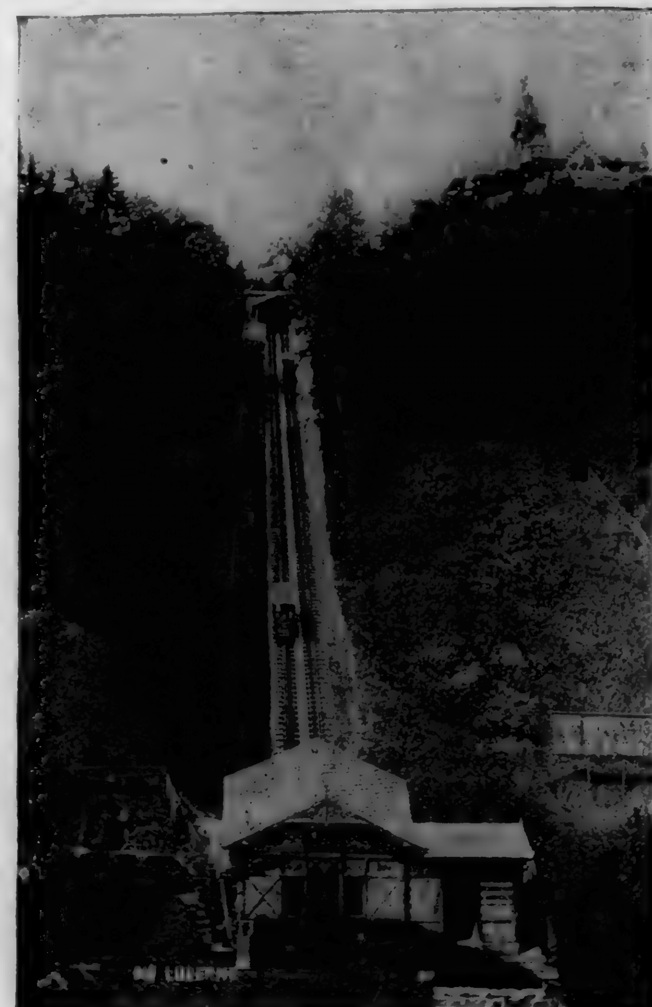
All this is said in no spirit of discouragement, for I yield to no man in my confidence in the future of electric traction. No new field is so rich, none more pregnant with great possibilities; but the growth of the work will be more expeditious and healthy if we separate the visionary from the real, the impracticable from the practicable.

SOME SWISS RAILROAD NOTES.

From an Occasional Correspondent.

There are many street railroads in Switzerland where steam is the motive power. Some of these serve a double purpose, for in addition to level road work they climb the hill and mountain sides to the points where the specially designed mountain roads begin. A number of the street railroad motors or locomotives are therefore built to work over a rack-rail as well as on a level.

Some of the mountain roads have extraordinary grades. The Glion line, near the Lake of Geneva—which is a cable road—has an incline of 57 per cent. The majority of the roads, however, vary between 50 and 25 per cent. grades. The number of these roads is increasing, and it is probable that before many years there will be a railroad part of



THE GUTSCH CABLE ROAD AT LUCERNE.

the way up Mont Blanc, though there are some tremendous difficulties to be overcome.

The illustrations given are from photographs by Jullien, of Geneva. One shows the Gutsch road at Lucerne. This is a cable line, and is almost the only one of the mountain roads having a double track.

The second shows a view taken on the rack-railroad up Mont Pilatus, which is worked by locomotives; it well illustrates the wild nature of the scenery, and some of the engineering difficulties which had to be overcome.

The third is a view on the Righi Railroad, also a rack-rail line worked by steam; while the fourth shows the lower terminus of the Righi road. The appearance of the locomotives, built to work on an incline, is peculiar when they are brought down on a level, as in this view.

A variety of engines are used on these roads. A very common form has a vertical boiler set on a bare platform or frame which carries the cylinders and other machinery.

VIEW ON THE PILATUS RAILROAD.

VIEW ON THE RIGHI RAILROAD.

LOWER TERMINUS OF THE RIGHI RAILROAD.

Line tunnel now being constructed in Baltimore to avoid the necessity of boat transfer at Locust Point. The duty of the motor here will be to propel the train with engines coupled on but not in operation through a tunnel about 6,000 ft. long. The conditions require motors which will weigh about 80 tons, and have a capacity of about 1,200 H.P. to propel a 1,200-ton freight train up a grade of 42 ft. to the mile at a speed of 15 miles per hour. Passenger trains of 450 tons' weight must be regularly started from rest twice in the tunnel on this grade, and in an emergency the motors must start the freight train. The draw-bar pull under regular duty, and when not starting, may be as high as 32,000 lbs.

Perhaps the traffic from New York to Philadelphia affords as good an example as any of what may be done on regular passenger service, provided the track is clear enough. For this, I some three years ago, and again in the *Forum* of September, 1891, outlined an electric express service with a method of supply through a rod carried above the car and a return circuit through the rails and earth. The current was to be supplied from one or more central stations equipped with high-class triple-expansion engines driving multipolar dynamos directly coupled. What the electrical engineer and the railroad men as well needs to know is whether the electromotice force required on the line and the number of stations necessary would be prohibitory.

No attempt was made for an excessive speed, but I confined myself to the average speed of a mile a minute for a distance of 90 miles, and considered a through service only. I assume a total weight of copper of only about two-thirds that which exists on the long-distance telephone line between New York and Boston. The trains were to be two-car units leaving every ten minutes.

I found with these conditions the stations and potentials would be about as shown in the following table :

Station	Miles apart.	Potential.	
		Two-wire	Three-wire.
1	—	[illegible]	1,800
	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

If the three-wire system is used—that is, the rails as a compensating conductor between two trolley roads—then with only two stations 45 miles apart it is seen that the potential is less that 1,000 volts, and this we undoubtedly can handle.

I am not prepared to say that we may not use even a higher pressure, because I believe whatever is demanded in the interests of economy, all things being considered, will be used, but if we can reduce the potential to perfectly safe and reasonable limits by multiplying the number of stations, then those stations should be increased so long as the increase does not seriously affect the general expense of working. On a service of this character, where I have made the conditions, distributed work and the dispatching of units at brief intervals—which conditions, I repeat, are absolutely necessary if we are to consider long-distance transportation by electricity—such increase of stations as is advisable will not increase the cost of central station operation.

Such is the work before you—a work well meriting your best efforts, yet it is well to temper your enthusiasm with prudence. Limit your attempts to the solution of those problems which will prove of practical benefit. Remember that neither sentiment nor ignorance, but lessened costs of operation for equivalent duty and increased returns on invested capital are winning cards.

All this is said in no spirit of discouragement, for I yield to no man in my confidence in the future of electric traction. No new field is so rich, none more pregnant with great possibilities ; but the growth of the work will be more expeditious and healthy if we separate the visionary from the real, the impracticable from the practicable.

SOME SWISS RAILROAD NOTES.

From an Occasional Correspondent.

There are many street railroads in Switzerland where steam is the motive power. Some of these serve a double purpose, for in addition to level road work they climb the hill and mountain sides to the points where the specially designed mountain roads begin. A number of the street railroad motors or locomotives are therefore built to work over a rack-rail as well as on a level.

Some of the mountain roads have extraordinary grades. The Glion line, near the Lake of Geneva—which is a cable road—has an incline of 57 per cent. The majority of the roads, however, vary between 50 and 25 per cent. grades. The number of these roads is increasing, and it is probable that before many years there will be a railroad part of

THE GUTSCH CABLE ROAD AT LUCERNE.

the way up Mont Blanc, though there are some tremendous difficulties to be overcome.

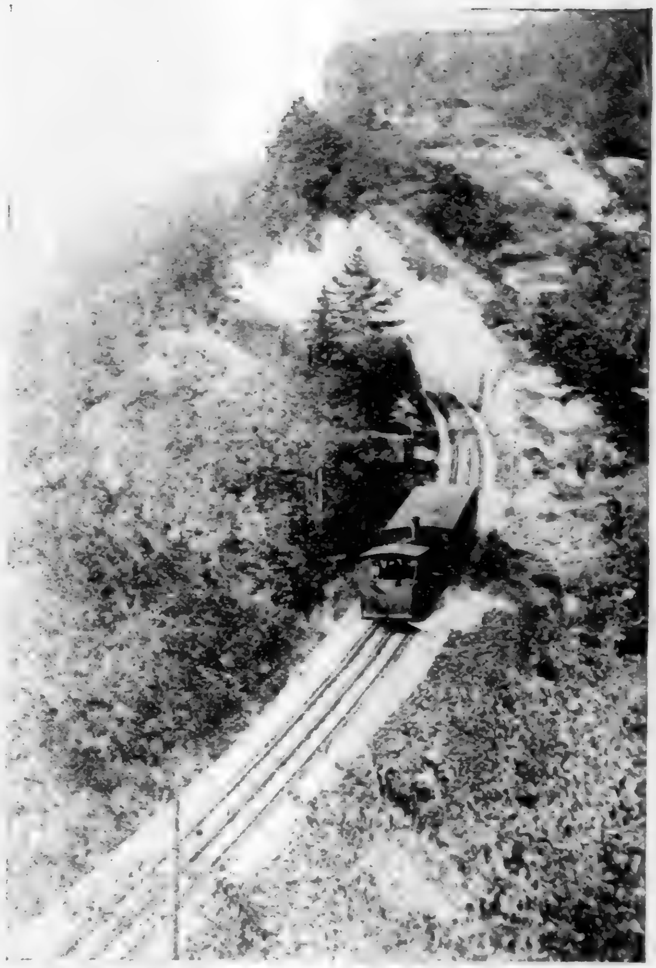
The illustrations given are from photographs by Jullien, of Geneva. One shows the Gutsch road at Lucerne. This is a cable line, and is almost the only one of the mountain roads having a double track.

The second shows a view taken on the rack-railroad up Mont Pilatus, which is worked by locomotives ; it well illustrates the wild nature of the scenery, and some of the engineering difficulties which had to be overcome.

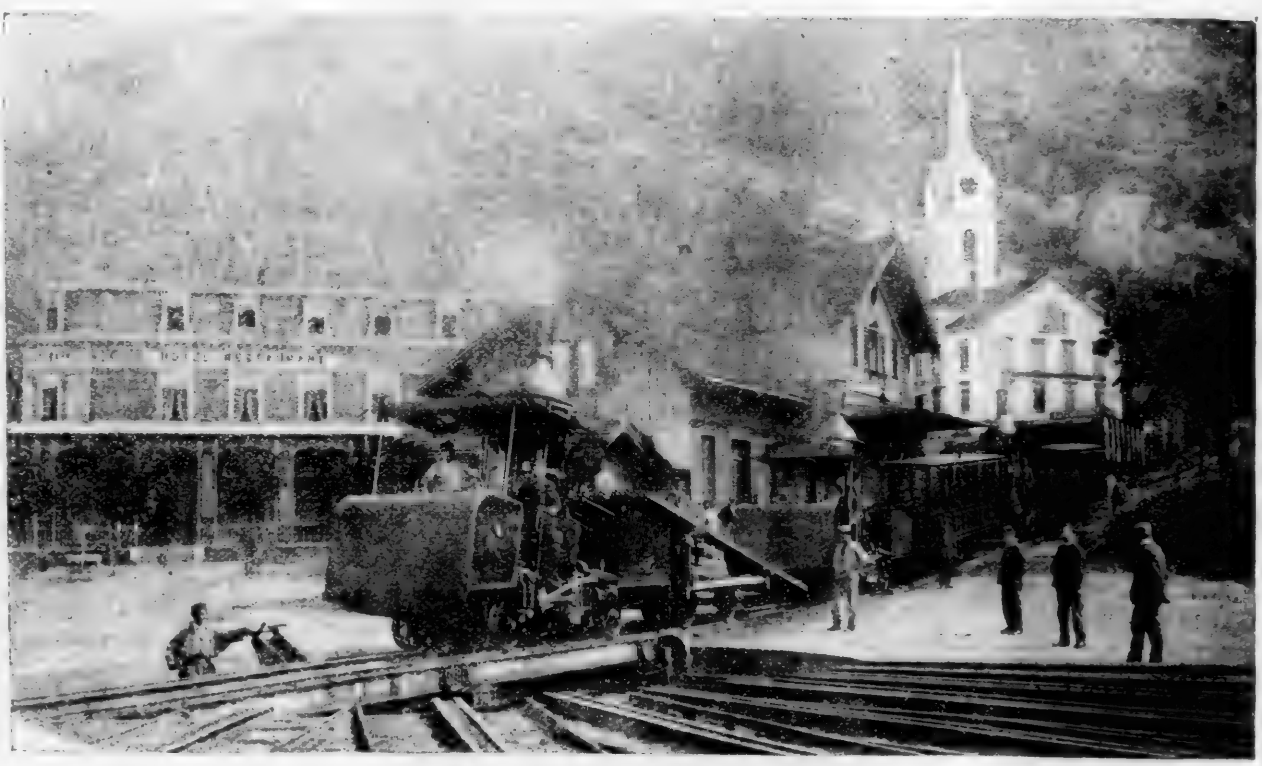
The third is a view on the Righi Railroad, also a rack-rail line worked by steam ; while the fourth shows the lower terminus of the Righi road. The appearance of the locomotives, built to work on an incline, is peculiar when they are brought down on a level, as in this view.

A variety of engines are used on these roads. A very common form has a vertical boiler set on a bare platform or frame which carries the cylinders and other machinery.

VIEW ON THE PILATUS RAILROAD.



VIEW ON THE RIGHI RAILROAD.



LOWER TERMINUS OF THE RIGHI RAILROAD.

The boiler is usually set at an angle so as to carry the water properly on the road.

While Switzerland is the home of the mountain railroad, and the country where it has reached its greatest development, the traveler from America will find the speed hardly satisfactory. Most travelers have noted the difference between the quick-moving elevators in the large buildings in New York and Chicago and the tortoise-like hydraulic "lifts" of European hotels. The difference is almost as great on the mountain roads, making the tourist long to get out and push, or, at least, to get over the ground faster by walking.

The ordinary roads make reasonably fast time, but the mountain roads have not the spur of competition to hurry them. The cost is so great that no one would undertake to build a second line, and the management is as economical as possible.

Nevertheless, these mountain roads are a great benefit to tourists, and have very much reduced the labor of seeing the mountains. Perhaps too much ought not to be expected of them, and they fill the demand reasonably well. Still they are slow to make improvements; and a traveler cannot help thinking that were the Righi in New York State better time would be made up its sides.

On my last visit to Switzerland, when passing through the second longest tunnel in the world—that which pierces Mont Cenis—I made as careful an inspection as possible from the carriage window, to see what it was looking like after twenty years' service. The entry to the eight-mile tunnel from the Italian side is fittingly monumental and impressive, huge stone columns supporting the arch over the portal. Once in the tunnel the train continues to mount slowly for half a mile; then come about four miles of level grade, then suddenly begins a steep down grade for the remaining three and a half miles. When this grade begins the train is for a few minutes in violent flight, the speed being fearful; the brakes are applied hard, causing showers of sparks to fly off from the wheels, so that the tunnel is for the moment almost lighted up. The steam-brakes used soon fill the tunnel with grit-laden vapor. About this point a train is usually met struggling up the steep grade.

The Mont Cenis tunnel is one of the dirtiest in the world. One cannot look out of the window for a few minutes without getting covered with soot and grit. The air in the tunnel is very unhealthy; there is the cold damp which has been there from the beginning, making the place feel like an ice-house. The ventilation is very defective, and the artificial illumination very poor. The carriages are very poorly lighted also, and the speed at which trains pass through is low. It takes about half an hour to go through, so that it is a very tedious transit.

A RUSSIAN FREIGHT ENGINE.

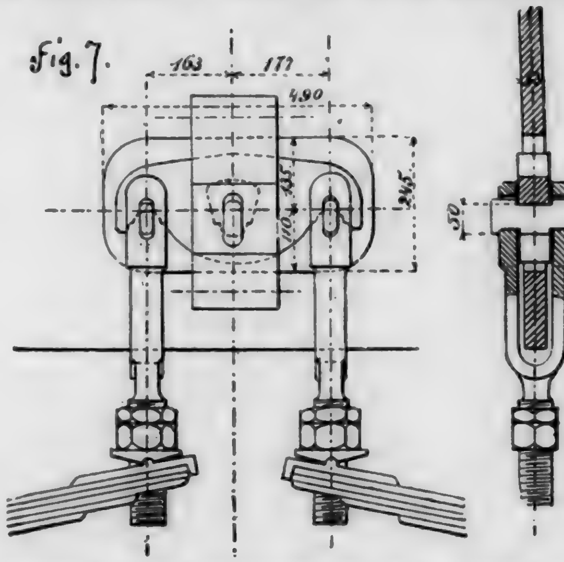
The drawings given herewith show a tank engine for heavy freight or pushing service which is illustrated and described in a recent number of the *Journal* of the Society of Russian Engineers. Fig. 1 is a side elevation; fig. 2, a longitudinal section; fig. 3, a half cross-section; fig. 4, a half front view; figs. 5 and 6 are half plans, one with the boiler removed. The dimensions on the drawings are in meters.

The engine is carried on eight wheels, all coupled. The cylinders are outside, but the steam-chests are inside. The boiler is of the straight topped type, the fire-box crown-sheet being arched and supported by stay-bolts extending to the outer crown-sheet. The boiler barrel is 57.9 in. in diameter, and has 212 tubes 12 ft. 1.6 in. long. The fire-box is shallow, and is raised entirely above the axles, as shown in fig. 2. The grate area is 19.9 sq. ft. The saddle under the smoke-box is of iron plate, the cylinders being attached at the side, as shown in fig. 3; this is a very common arrangement in Russia and Germany, where the cast-iron saddle is not favored. The heating surface is: Fire-box, 98.5; tubes, 1,356.3; total, 1,454.8 sq. ft. The working pressure is 150 lbs.

The cylinders are 19.7 in. in diameter and 25.6 in. stroke. It will be noted that the old arrangement of continuing the piston-rod through the front cylinder-head is still carried out in this engine. The valve motion is of the shifting link type. The driving-wheels are 47¼ in. in diameter.

The frame is of the plate type. The springs of the first and second pairs of wheels are carried above the frame;

Fig. 7.



those of the third and fourth pairs are below the axles, and are equalized by an arrangement shown on a larger scale in fig. 7.

Water is carried in two side tanks, and coal in a box placed in the rear end of the cab. The engine has at each end the double buffers and screw couplings in general use on the Russian roads. The cab is entirely closed in, the engine being arranged to run in either direction.

The total wheel base is 12 ft. 9 in.; the total length of the engine over all is 33 ft. 1½ in. The total weight is 124,746 lbs., which is divided as follows on the four axles: First, 31,032; second, 31,209; third, 31,429; fourth, 31,076 lbs.

The general construction of the engine and many of the details can be very clearly seen from the drawings.

NOTES ON A PROBLEM IN WATER POWER.

(Paper read before the American Society of Mechanical Engineers at the meeting of May, 1892, by John Richards, of San Francisco.)

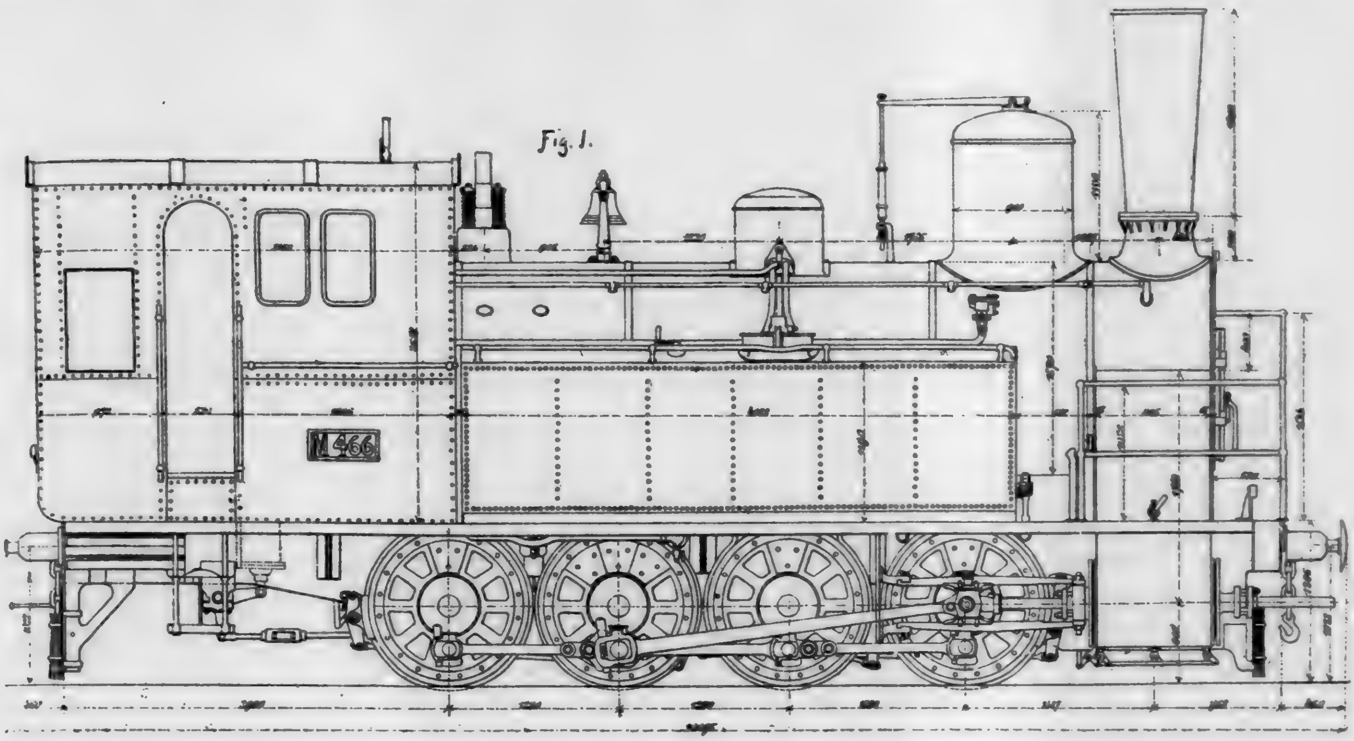
The present paper is to be a non-scientific one, and in other respects is not to be classified among the contributions such as are commonly presented before this Society. Neither are its objects the same. The purpose is to present some thoughts upon a very important subject, with a view to calling out further and more able discussion. There being nothing exact or determinate to deal with, there will be neither figures nor quantities included, so that no severe mental strain need be apprehended in following the remarks.

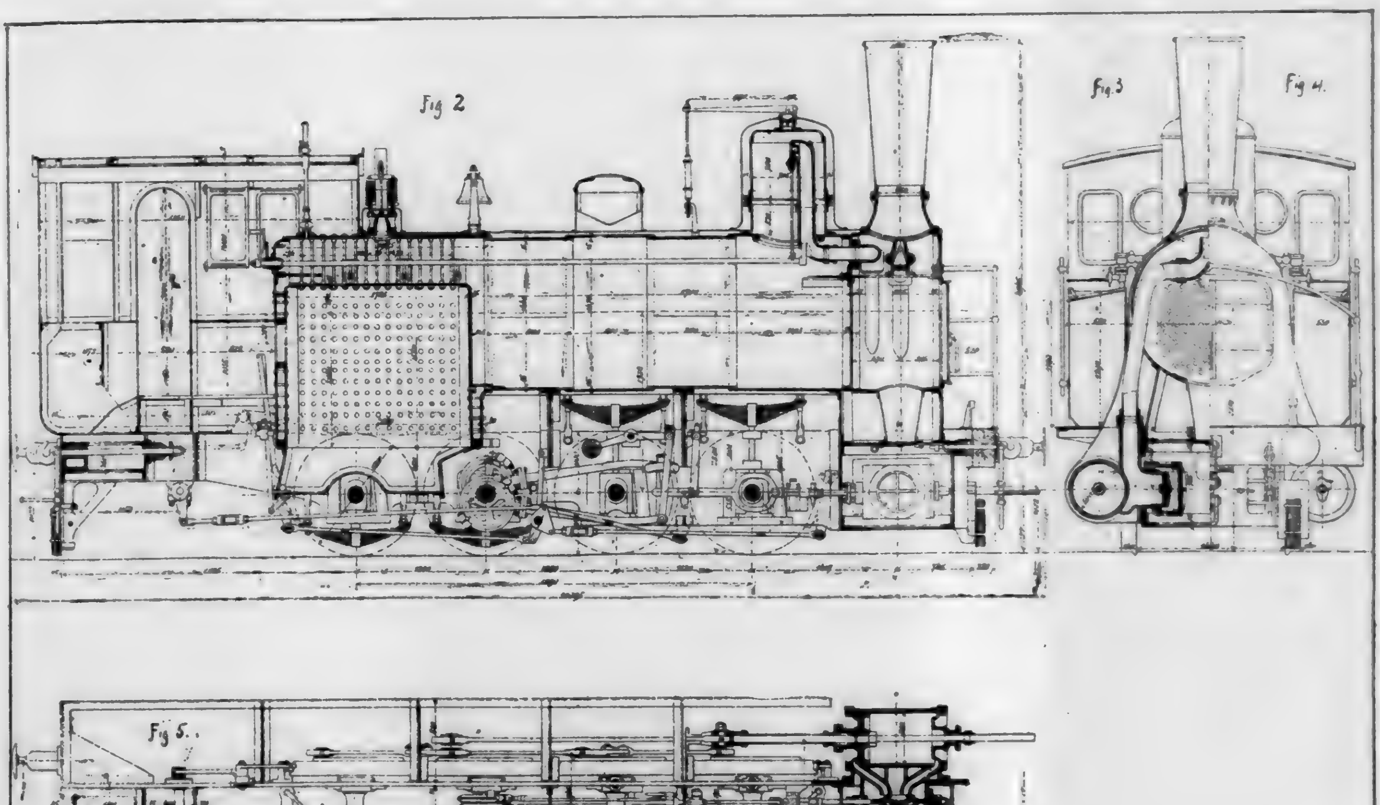
The subject is Water Motors, or, as we commonly say, Water Wheels, for utilizing the action of gravity of water, and an inquiry into the probable conditions, inferences, or deductions which have led up to and established modern practice as it now exists in this country.

Water wheels, as we have to deal with them, may be classed as gravity wheels, including (1) overshot breast wheels, and perhaps the Poncelet type; (2) pressure wheels, including what we call enclosed turbines and reaction wheels; (3) impulse wheels, driven by spouting water.

The classification thus assumed is, for short: gravity, pressure and impulse wheels. These may be said to cover the various types in common use.

In modern practice the class called pressure turbine wheels constitute perhaps four-fifths of the whole. These can be divided into three general types—namely: The Fourneyron, or outward radial discharge; the Jonval, or





A HEAVY RUSSIAN TANK LOCOMOTIVE.

downward discharge parallel to the axis of rotation ; and the American or inward flow wheels. These have come into general use all over the world, and have a literature of surprising completeness. They are by common consent regarded as the most efficient, and, indeed, until recently, have been the only wheels which were considered in connection with an efficiency beyond 60 per cent.

The question to be presented and the main point in this communication is, what has produced this particular form of evolution in water-wheel practice, and why has pressure instead of impulse been the principle or mode of operation followed in all countries ?

Before attempting any answer to this inquiry, it will be well to further examine or explain, in as simple a manner as possible, the nature of the class called turbine wheels.

A column of water resting upon the vanes of a turbine wheel, which are free on their reverse side, and meet no resistance there, represents complete efficiency less machine friction ; and the science of turbines, to so call it, is directed to removing the impeding water and its resistance on the reverse side of the vanes—that is, on the discharge side, after the function of pressure has ceased or has been utilized. It is common to divide the effect of the water, or its functions, in this class of wheels, into gravity, impulse and reaction, but there is no need of such assumption or of introducing the complex nature of these forces thus combined, because the whole is explained as simple pressure, and all observed phenomena point to this as the "mode of action" in pressure turbines.

I am in this assumption, no doubt, transgressing upon what are called established data, but the issue is not important to the present subject, and it will be sufficient to call the active force one of pressure alone, and the resistance or loss a result of the imperfect riddance of the water on the reverse or discharge side of the vanes, after it has performed its work by pressure, impulse or otherwise.

Following this method of operating to its constructive features, it involves closed vessels, or conduits, not only to the water wheels, as in other cases, but around them. The wheels must be enveloped in the fluid that drives them, and contained in cases strong enough to sustain not only the static head, but also the effect of water concussion, and in most cases afford support for the wheels themselves and their shafts.

The bearings of the wheels have to sustain the weight of the running parts, also, in many cases, a pressure of the head equal to area of the issues multiplied into the head. The wheels are submerged, placed at the bottom of the head or near it, inaccessible to observation, and also for repairs, calling for unusual and expensive provision in the way of bearings and other constructive features, including extra strength of all parts. The hydrodynamic conditions both of entrance and discharge call for complicated forms that cannot with safety be built up, and pressure turbine wheels in this way become large and expensive castings, the value of which depends upon the integrity of every part. If a vane be broken or imperfect, the whole wheel is lost. The diameter being limited because of first cost, a limit of rotative speed is reached at a head of 50 ft. or so, and even at that head the bearings have to run under undesirable conditions ; in other words, this type of wheels does not permit control of rotative speed, that being limited by both first cost and operating conditions.

Turning now to the other type of wheels, but little known in this country, except on the Pacific Coast, the impulse class, and assuming that the force of spouting water is equal to its gravity less an inconsiderable friction in orifices, the question arises, why has not the evolution of water wheels followed on this line instead of pressure for all except low heads ?

This is a very important question, one that may well engage the attention of this Society, and one that calls for explanation such as will be by no means easy or apparent. It is true that with that class of impulse wheels called "undershot," and some other cruder forms operating by the impulse of spouting water, the efficiency attained has been so low as to lead to the conclusion that the losses were inherent in the method or mode of operation, and this opinion has, it seems, become general without any one very closely inquiring into the matter.

That the efficiency of tangential wheels driven by impulse is as high as can be attained by pressure turbines, has been proved by numerous experiments here, also by some recent experiments at Holyoke, Mass., and is beyond controversy. It has long been settled on this Coast, and as a problem no longer exists. No one here would expect under a head of 50 ft. or more to attain with any known type of pressure water wheels a higher efficiency than is given out by tangential impulse wheels ; but this state of opinion and practice is confined to narrow limits now, and is the more to be wondered at when we consider the rapidity and completeness of investigation in other branches of dynamic engineering at the present day, especially when the economic and constructive conditions in favor of the impulse type of water wheels are taken into account. These we will now consider in a brief way.

There is a wide difference between a water wheel driven by impulse and one operating on the pressure system. The first cost of the former, for a given power, is one-half as much, and its maintenance is still less, in proportion.

Figuratively speaking, when a wheel is changed from the pressure to the impulse system, it is taken out of its case, mounted in the open air, in plain sight. All the various inlet fittings are dispensed with and are replaced by a plain nozzle and stop-valve. Its diameter is made to produce the required rotative speed, whatever that may be. The shaft and its bearings are divested of all strains except those of gravity and the stress of propulsion when the water is applied at one side only. Most important of all there are no running metallic joints to maintain against the escape of water, no friction and no leaks ; there are, indeed, no running joints or bearings whatever, except the journals of the wheel shaft.

The effect of grit and sand is eliminated, both as to vanes and bearings, and there are no working conditions that involve risk or call for skill. If a vane is broken, another one is applied in a few minutes' time. If a large or small wheel is wanted, the change is inexpensive and does not disturb the foundations or connections.

Capacity is at complete control ; the wheels can be of 10, 100 or 1,000 horse power, without involving expensive special patterns. The speed of rotation is not confined to commercial dimensions because of patterns and other causes. It is merely a matter of choice with the purchaser or maker.

Now granting the efficiency of impulse wheels, which, as before remarked, can hardly be called in question for all heads exceeding 50 or even 30 ft., and conceding the constructive and operating advantages just pointed out, the question at first named rises, why has the evolution of water wheels during 50 years past been confined to the pressure class ? Also, why has it been proposed at Niagara Falls to employ pressure turbine wheels under a head of 100 ft. or more, when the conditions point to the better adaptation of open or impulse wheels ?

It is not necessary in such an inquiry to discuss the problem of horizontal and vertical axis, or other local conditions, in the case of the Niagara plant, or in any other, further than to say that the pressure class of wheels offers no advantages not balanced by equal or greater disadvantages, as will no doubt appear if there should be discussion of this subject before the Society.

Besides the object of this communication first named, there is the further one of calling the attention of the members present to the impulse or open water wheels so extensively employed on this Coast, and to suggest that, if possible, they manage to see such wheels in operation under various heads, especially under high heads. In observing a machine of any kind in motion, there are impressions gained which cannot be conveyed by description, but I warn every one against inference from this remark that the tangential water motor wheels on this Coast are not scientifically understood and treated. The problems involved may not be so many or so intricate as in the case of pressure turbine wheels, and this is fortunate, because the literature of the latter is one of much complexity to any but skilled mathematicians, and for that reason has not been of so much use as it ought to have been.

in this country, and it is a most commendable thing to mention, the pressure turbine by an inward flow, or an inward draft, has been greatly simplified in construction, cheapened in first cost, and at the same time better adapted to impure water, without losing anything in efficiency. I believe the inward flow turbines made by the Risdon Company at Mount Holly, N. J., have in public tests on more than one occasion shown an efficiency as high, or even higher, than the more finely fitted Fourneyron and Jonval types.

The record of American engineers in this branch is one of which they may well be proud; and now that impulse wheels of the Girard type have made much progress abroad, and have here in California been modified much as the Fourneyron and Jonval wheels have been in the Eastern States, it is quite time more attention was bestowed upon the subject in other parts of the country. Analogy in the two cases is marked. By an inward flow, American makers reduced the running parts, or the wheel proper, of pressure turbines to a small diameter, increasing its speed accordingly. This lessened the weight and cost of the wheels in the proportion of their diameters, and at the same time dispensed with the accurate fitting involved in the outward and downward flow turbines; and this, as before said, has been done without sacrificing efficiency.

The tangential type of open wheels has been similarly dealt with here in California. The running-water joints have been wholly dispensed with. The construction has been cheapened one-half. The round jet has been applied in the most simple manner, with an increased dynamic effect, and the efficiency attained is believed to be more than is reached by the finest examples of Girard wheels in Europe.

Conceding these statements and facts brings us back again to the query forming the subject of this communication—namely, Why has the evolution of water wheels followed on the line of *pressure* instead of *impulse?*

VIADUCTS ON THE BOMBAY WATER WORKS.

(From *Indian Engineering*.)

THE annexed illustrations will have an interest in connection with the opening ceremonial about to take place of one of the largest water-supply projects ever undertaken in the world; we refer to the Tansa Scheme for the City of Bombay, just completed by Mr. W. Clerke, who has *engineered* the undertaking from first to last.

Through the courtesy of Mr. Clerke, we are enabled to give two views of the Duct. Fig. 1 is a view of the bridge over the main channel of the Bassein Creek. Fig. 2 is a view of an aqueduct near the Vehar Lake.

Fig. 1.

Fig. 2

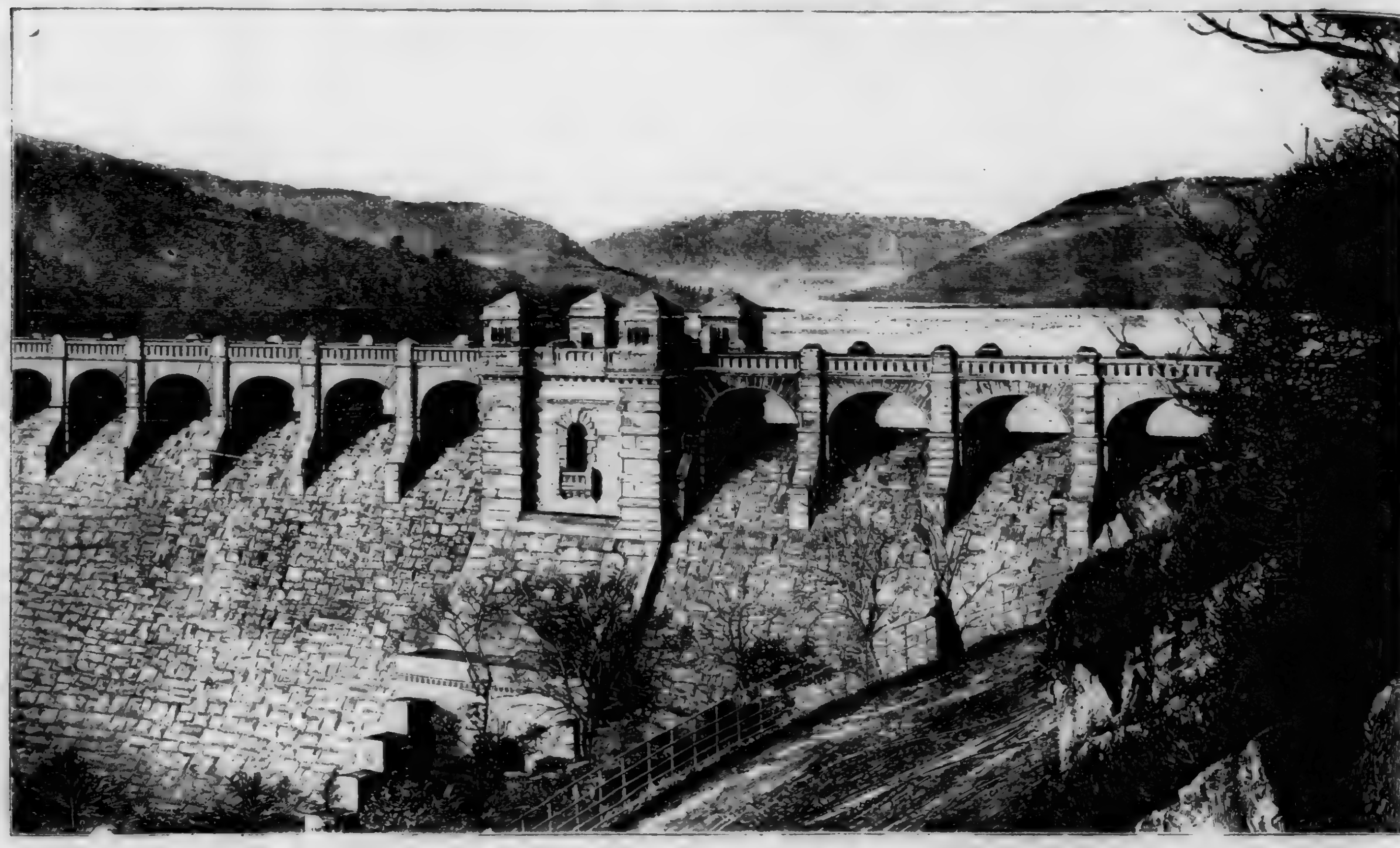
VIADUCTS ON THE NEW WATER WORKS FOR BOMBAY, INDIA.

The bridge which carries the Tansa 48-in. pipe over the main channel of the Bassein Creek, which separates the island of Salsette from the main land, is situated at 32 miles on the Duct line from the outlet works at Tansa. It consists of 15 spans, 100 ft. centers, with a gradient of 1 in 40 from each end to the center span which is horizontal. This span gives a clear headway of 22 ft. over high water spring tides. Each abutment and pier consists of a pair of cast-iron cylinders 5 ft. diameter up to low water spring tides. At this level they reduce to 4 ft. diameter by a taper piece. Each cylinder is sunk to rock level, and some of them are 75 ft. under surface of ground. They are filled with lime concrete, and each pair of cylinders is braced together from low water spring tides upward by wrought-iron horizontal and diagonal bracing. The superstructure consists of wrought-iron lattice girders 18 ft. apart centers. The girders are 9½ ft. deep. The lower booms carry cross girders of rolled beams laid 9½ ft. apart. The bridge is designed to carry two lines of 48-in. pipes, one on each side close to the main girders, and a line of tramway 2½ ft. gauge in the center. Only one line of pipes is at present laid. Two smaller bridges, each of four spans and of similar construction, carry the pipe line over two smaller channels of the Bassein Creek.

The aqueduct shown in fig. 2 carries the masonry conduit along the ridge to the east of the Vehar Lake. It is situated at 41 miles on the Duct line from the outlet works at Tansa. The aqueduct consists of 15 spans of 20 ft. with three arches of 10 ft. span at the north end and six arches of 10 ft. span at the south end. The greatest height from ground level to springing of arch is 20 ft. The aqueduct carries the masonry conduit, which is 7 ft. wide between the side walls and 6 ft. high to springing of arch. The arch has a rise of 15 in. and is 8 in. thick. There are numerous aqueducts of this type on the line of the Duct, but the one represented in the illustration is the largest and most important of its class.

THE LIVERPOOL WATER-WORKS.

THE new water-works for the supply of the city of Liverpool in England were formally opened on July 14. These works present many interesting points; they consist of the dam and reservoir at Vyrnwy in Wales, and of



THE VYRNWY DAM.

an aqueduct 68 miles long—claimed as the longest in the world—carrying the water to the point of distribution near the city.

For the facts given in the following condensed account, and for the illustrations, we are indebted to an interesting and complete description given in the London *Engineer*.

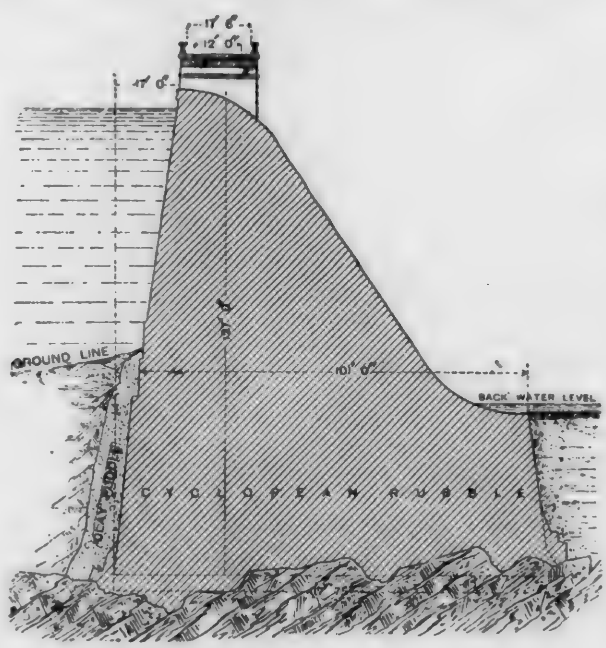
The starting-point of the new water-works is at Lake Vyrnwy, in the mountains of Wales, where a lake with a storage capacity of 12,131 000,000 ga lons has been made by the erection of a fine masonry dam across the valley. The water is collected from a drainage area where there is a large rainfall, and all the circumstances favor the purity and excellence of the supply. The storage capacity is so great, that a failure or deficiency in the supply is hardly possible under any circumstances.

The Vyrnwy River is a tributary of the Severn, and at the point selected for the great reservoir flows through a deep valley where the conditions are exceptionally favorable. The lake or reservoir formed by the dam is 4.75 miles long and varies in width from 0.25 to 0.625 mile. The dam itself is 1,172 ft. in length, from the rock on one side of the valley to that on the other. It is 161 ft. high in the center from the foundation to the parapet of the roadway crossing it. The height from the river-bed is 101 ft. to the parapet and 84 ft. to the sill over which the overflow passes—that is, between the arches supporting the roadway. The greatest thickness of the dam at the base is 120 ft, and the width of the roadway on top is 19 ft. 10 in. The batter of the front or water-face of the dam is 1 horizontal in 7.27 vertical; the slope of the back of the dam above ground level is 1 in 1.5.

A general view of the dam is given herewith, which gives an excellent idea of its appearance and the surroundings of the lake. A cross-section of the dam is also given.

Water is drawn off to the aqueduct through a tower placed at the side of the lake, and provided with special arrangements for taking it at the best level to secure purity and to prevent silt or solid matters from entering the pipes. A view of this tower, which is very picturesque in design, is also given.

The aqueduct is 68 miles in length from Lake Vyrnwy to the Prescot Reservoir, which is nine miles from the Liverpool Town Hall. It is designed throughout for three lines of pipes having a total capacity of 40,000,000 gallons per



SECTION OF VYRNWY DAM.

day; but at present only one of these lines is laid, carrying 13,333,000 gallons.

The aqueduct commences with the Hirnant Tunnel 2.375 miles long, at the outlet of which the water enters

the pipes, which are carried underground for seven miles, except for a short distance, across the Aton, where they are carried over a bridge. The other streams on this section are passed by inverted syphons. This section ends at the Parc-Uchaf balancing reservoir, which is on a hill rising nearly to the hydraulic grade.

From this point follow 6.125 miles of pipe; then the Cyninion Tunnel, 0.875 mile, a bridge over a narrow valley and the Llanforda Tunnel about a mile long. The latter discharges into the Oswestry balancing reservoir, which is the largest on the line. The local conditions being favorable, this was made also a storage reservoir, where a supply of 46,112,000 gallons is held to provide for emergencies. About 0.75 mile farther on are the sand filtration beds and a clear-water reservoir with a capacity of 2,812,500 gallons. Two others, of equal capacity, are to be provided when the full capacity of the aqueduct is needed.

From the clear-water reservoirs to Malpas, 17.625 miles, the pipes are underground, except at Wych Brook, which is crossed by a bridge of masonry. Two branches of the Great Western Railway and the Shropshire Canal are passed in subways on this section, which ends in a balancing reservoir on Oat Hill. From this another section of underground pipe, 11,625 miles long, leads to the Cotebrook balancing reservoir.

From Cotebrook 11 miles of underground line extend to Norton Hill. On this section the River Weaver is passed by three steel pipes laid in a trench dug out in the bottom of the river, to a depth of 21 ft. below the water-level. The pipes are covered and protected by a bed of concrete. In order to reach the hydraulic grade at Norton Hill the balancing reservoir there consists of a tower rising to a height of 100 ft. This tower is of masonry, and supports

INLET TOWER, VYRNWY WATER WORKS.

a steel tank 82 ft. in diameter and having the form of an inverted dome. The tower carries on its summit a heavy ring of cast-iron set in cement; upon this is a complete ring of turned steel rollers, 12 in. in diameter, and upon these rollers the steel flange of the tank rests.

This tower is of a striking design, as is shown in the accompanying illustration.

THE NORTON TOWER, VYRNWY WATER WORKS.

From the Norton Tower the last section extends for 10.375 miles to the Prescot Reservoir, which is the distributing reservoir for the city system. On this section is the most costly and troublesome work on the line, the tunnel by which the pipes are carried under the River Mersey. This tunnel was driven from two shafts and was built on the Greathead system; the south shaft is 46.5 ft. deep and the north shaft 52.75 ft. The tunnel itself is 805 ft. long, 9 ft. inside and 10 ft. outside diameter; it carries at present a single line of pipe, but is all ready to receive a second line when needed. The drainage and waste water of the tunnel is collected in a well, whence it is removed by pumps.

It may be added that the designing and construction of the works has been under charge of Mr. G. F. Deacon, who has conducted them from the beginning. The cost is given at $10,500,000, which seems very moderate indeed.

THE NICARAGUA CANAL.

In a lecture recently delivered before the Franklin Institute in Philadelphia, Mr. George W. Davis, General Manager of the Construction Company, gives the following summary of the work thus far accomplished, which may be taken as an official statement. It may be added that Mr. Davis' lecture contains a very strong plea for the canal and for the many advantages to be secured by completing it as soon as possible, and for retaining the control of it in this country:

The Company has gone to its work of building the canal in a plain, unostentatious, systematic manner, and although nearly all accomplished to date may be described as preliminary, yet a very important advance has been made. These results may be summarized as follows:

1. The completion of the final surveys for location and construction.

2. The subterranean examination of the strata requiring removal, by means of borings with the diamond drill.

3. The restoration of the harbor of San Juan del Norte

to the extent of securing an easy entrance to the port for vessels of 12 ft. draft.

4. The construction of extensive wharves and landing facilities.

5. The erection of permanent buildings for offices, quarters, hospitals, store-houses, shops, etc., having a floor area of an acre and three-fourths.

6. The building of a large number of temporary camps along the line for accommodation of employés.

7. The completion of a telegraph line permitting ready communication of the New York office with any part of the work.

8. The clearing of the canal line of timber for some 20 miles.

9. The completion of surveys for location and plans of construction of the railroad system, and the construction and equipment of 11 miles of this line.

10. The acquisition by purchase of the most valuable and powerful dredging plant to be found in America, under one management.

11. The fitting up and operation of this plant and the opening of nearly a mile of the canal.

12. The acquirement by purchase of the valuable and exclusive franchise for the steam navigation of the San Juan River and Lake, together with the extensive plant of the Navigation Company, consisting of offices, lands, steamboats, tugs, lighters, repair shops, etc.

13. And lastly, what is felt to be the most important result of all is the demonstration, secured by experience, of the salubrity of the climate, the efficiency of labor, and the sufficiency of the estimates of the Chief Engineer for the harbor and canal dredging and railroad work.

Finally, the Government of Nicaragua has formally made acknowledgment of the fact that the Company has fully complied with the requirement imposed by the canal grant, which provides that the work of construction shall not be considered as commenced unless $2,000,000 are expended in the first year. This formal acknowledgment confirms the Company's title to the concessionary rights for a term of 10 years in which to complete the canal and open it for traffic.

THE GUNBOAT "YORKTOWN."

The accompanying illustration is from a photograph of the gunboat *Yorktown*, one of the smaller vessels of the new Navy. The *Yorktown* was built at the Cramp yards in Philadelphia, and was launched there April 28, 1888. She has now been in commission for some time, cruising in various waters, and has proved herself a useful ship. In appearance she is certainly a very handsome boat.

The *Yorktown* is a light, unarmored cruiser or gunboat of steel, divided by water-tight bulkheads into numerous compartments. The chief dimensions are: Length on load water-line, 226 ft.; beam, 36 ft.; depth, 18 ft. 9 in.; draft, 13 ft. forward, 15 ft. aft, or 14 ft. mean; displacement, 1,703 tons. The ship carries three masts with fore-and-aft rig, and has a sail area of about 6,350 sq. ft.

The *Yorktown* has two vertical, direct-acting triple-expansion engines, with cylinders 22 in., 31 in. and 50 in. in diameter and 30 in. stroke. The twin screws are three-bladed, 11 ft. 6 in. in diameter. Steam is furnished by four boilers, each 9 ft. 6 in. in diameter and 17 ft. 6 in. long. The engines work up to 2,200 H.P. with natural draft and 3,300 H.P. with forced draft, and the speed at full power is 16 knots per hour.

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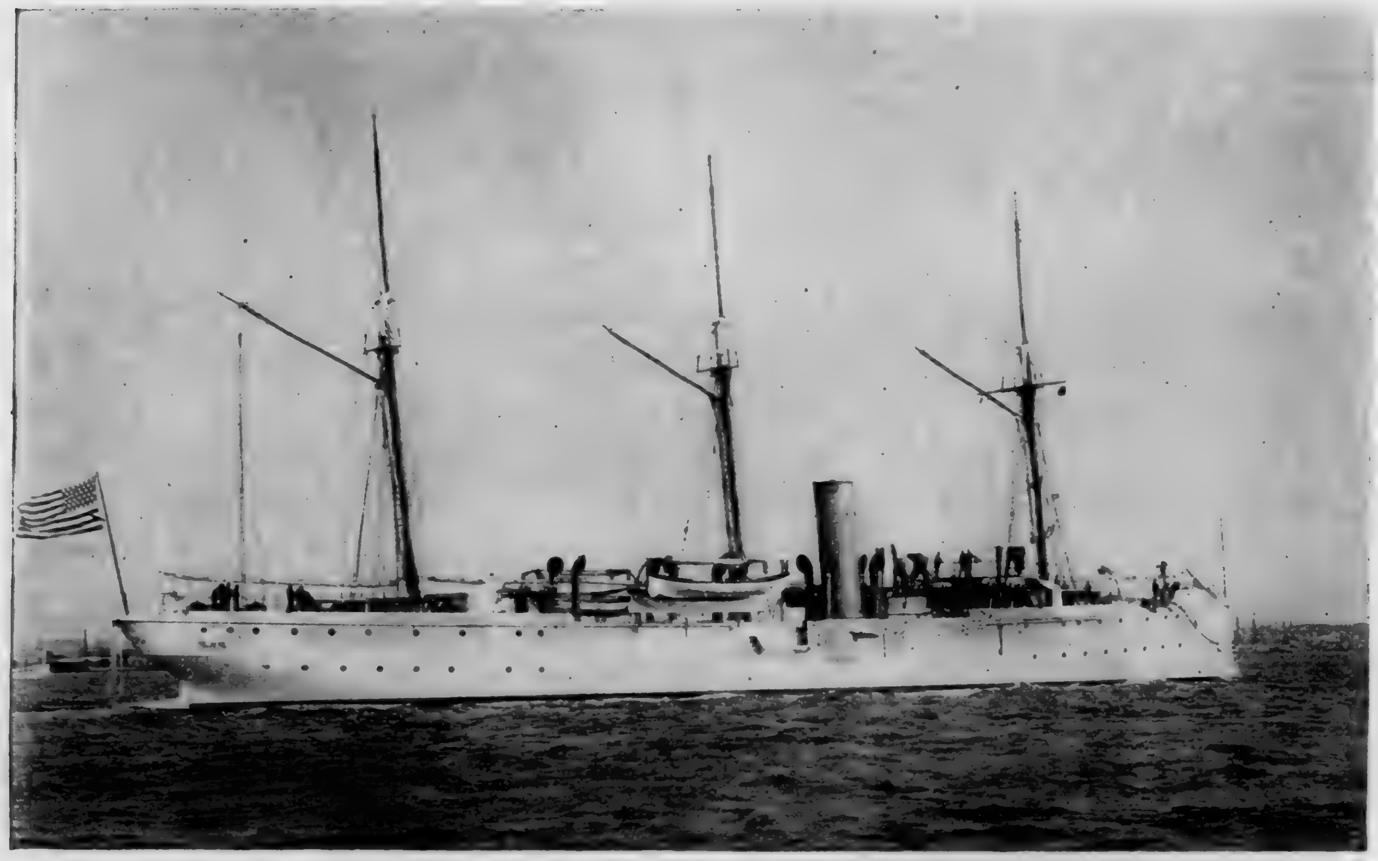
The ship is lighted by electricity, and has an electric search-light. Two independent light plants are provided. Especial attention has been given to ventilation of fire-rooms and quarters, and to providing comfortable quarters for the officers and crew, who number about 150 in all.

The *Yorktown* has two sister ships—the *Concord* and the *Bennington*—which are similar in almost all respects, but were built at the Roach yards in Chester, Pa., about a year later.



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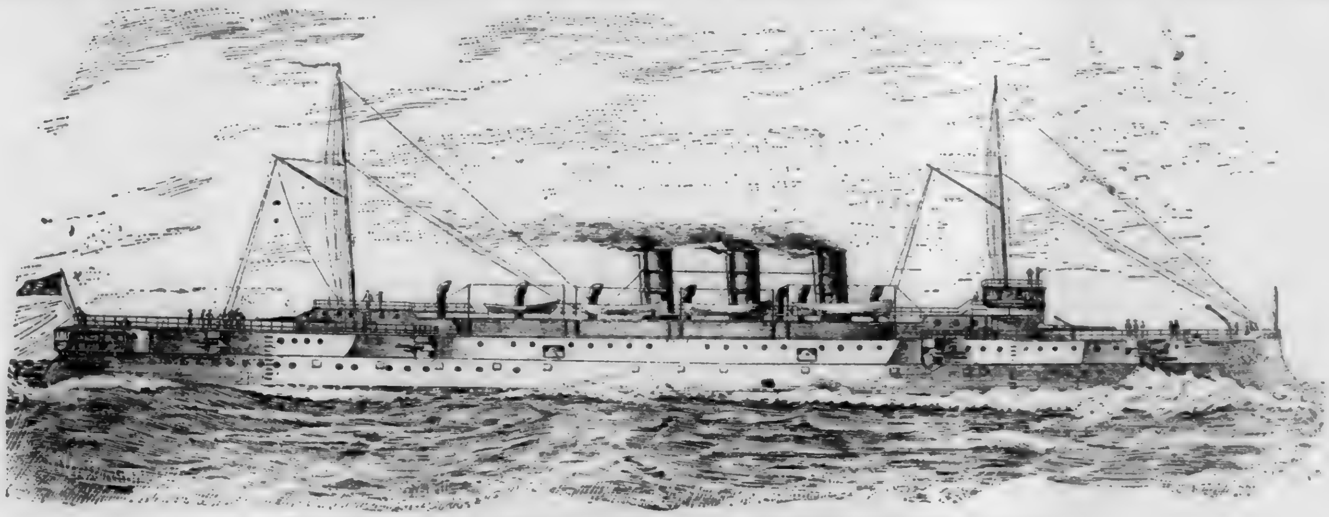

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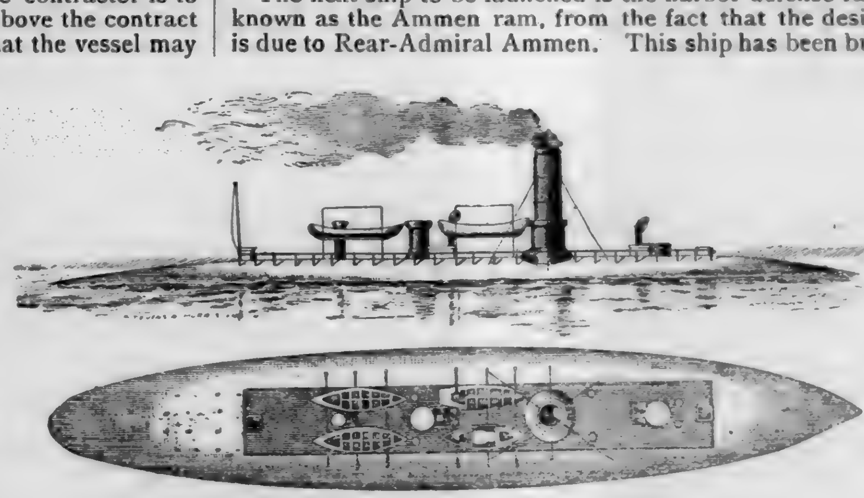

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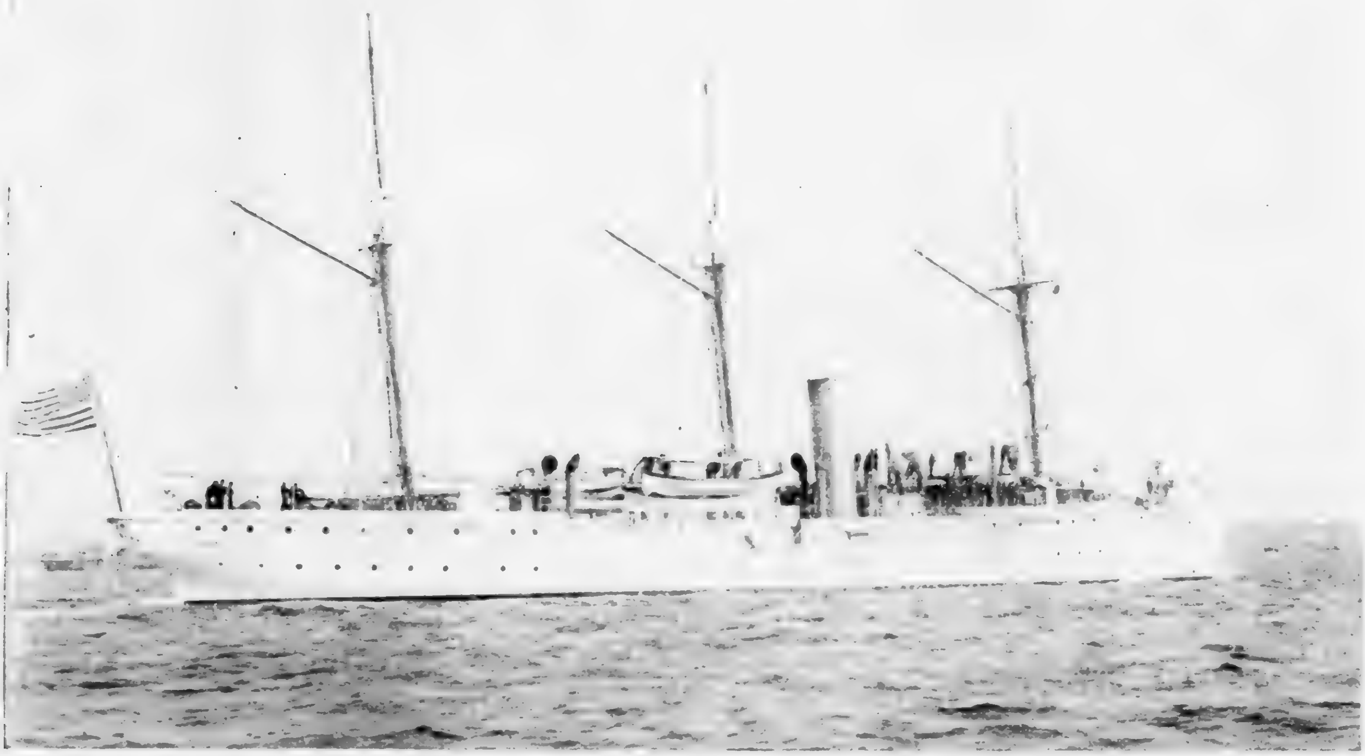

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HARBOR DEFENSE RAM, UNITED STATES NAVY.

The principal dimensions of this vessel are: Length over all, 243 ft.; length on load water-line, 242 ft.; extreme breadth, 43 ft.; breadth at water-line, 41 ft. 10 in.; draft amidships, 15 ft.; displacement, 2,050 tons; indicated H.P., 4,800; speed, 17 knots per hour.

The vessel is designed upon the longitudinal and bracket system, with an inner bottom extending from the collision bulkhead to the stern. The longitudinals and girders supporting the deck are continuous, converging to the stem casting and to the stern; the frames and beams are intercostal. The depth of the longitudinals and the vertical keel throughout their length is 24 in.; the girders supporting the armored deck are 15 in. The vertical keel, two longitudinals, and the armored shelf on each side of the vertical keel are water-tight, forming transversely six compartments, which are divided longitudinally by water-tight frames. By this means the space between the inner and outer skin is subdivided into 72 compartments. The transverse and longitudinal bulkheads between the inner skin and deck armor divide this space into 30 compartments, making a total of 102 compartments in the vessel.

The deck armor varies from 6 in. to 2½ in. in thickness, and the side armor from 6 in. to 3 in. All hatches through the armored deck are furnished with battle-plates, and the smoke-pipe and ventilators are to have inclined armor 6 in. thick. The conning-tower is 18 in. thick.

The ship is to be provided with a removable wrought steel ram-head to be accurately fitted and securely held in position in the cast-steel stem.

The framing of this ship is very heavy and strongly braced. As shown by the illustration, the greater part of the vessel will be submerged, while nearly all of the surfaces appearing above water are curved, leaving no opportunity for a square blow from a shot. The ship will carry no armament, depending entirely upon ramming for her offensive strength.

The only projections above the deck are the conning-tower, the smoke-pipe, the ventilators, the hatch-coamings, and the skid-beams upon which the boats are supported.

The officers' quarters will be on the after berth deck, and the quarters for the crew will be partly aft and partly forward. There will be a complete installation of electric lights arranged in duplicate. The drainage system will be so arranged that any compartment can be pumped out by the steam pumps. Foul air will be extracted from all parts of the vessel by means of blowers, fresh air being supplied from the main ventilator, through air ducts led along the inside of the deck.

The vessel will be submerged to fighting trim by means of fourteen 8-in. Kingston valves, one in each transverse water-tight compartment of the double bottom. Sluice valves will be fitted in the vertical keel, and the water-tight longitudinals in these compartments.

The engines are triple-expansion and of the horizontal type, each being in a separate compartment. There are four cylindrical horizontal fire-tube boilers placed in two water-tight compartments. The engines are required to develop 4,800 H.P. under forced draft, with a corresponding speed of 17 knots.

OTHER NEW SHIPS.

The third of the 2,000-ton cruisers, the contract for which was let to Harrison Loring, of Boston, was launched August 11. Work on this ship has been delayed somewhat by financial difficulties of the contractor, which have now been arranged, and by delays in delivering steel. She is a sister ship to the *Detroit* and the *Montgomery*, built in Baltimore, and now nearly completed.

Plans are being prepared for the new armored cruiser authorized by Congress. While this ship will have a general resemblance to the *New York*, it is probable that her displacement will be somewhat greater, most of the additional weight going into additional armor and heavier armament. The plans proposed provide for a battery of eight 8-in. guns carried in four turrets and twelve 5-in. rapid-fire guns; the secondary battery to include twelve 6-pdr. rapid-fire and several machine guns. The *New York's* battery is to include only six 8-in. guns, twelve 4-in. rapid-fire guns and eight 6-pdr. cannon.

Plans are also in preparation for the new battle-ship authorized. She will be probably of somewhat larger displacement and greater speed than those now under construction. It is said also that the triple-screw arrangement used in Cruisers 12 and 13 may be applied; but no definite decision has been made as yet.

ARMOR TESTS.

The first test of armor-plates at the new proving ground of the Bethlehem Iron Company at Bethlehem, Pa., took place July 30. The plate tested was a 10½-in. Harveyized nickel-steel plate, 8 × 6 ft. in size, and weighed 18,600 lbs. In tempering the plate it was treated with the ice-water process, which rendered its surface exceedingly hard and brittle.

Five shots from an 8-in. rifled gun were fired at the plate; four in the corners, and the fifth in the center. The charges consisted of 81½ lbs. of powder and a 250-lbs. Holtzer projectile. The velocity of the projectile was 1,700 ft. a second.

Each projectile pierced the plate about three inches, rebounded, and broke into bits the size of walnuts. Not a single crack was developed in the plate.

The test was witnessed by several officers of the Navy and was regarded as a very successful one.

A COMPOUND STATIONARY ENGINE.

THE accompanying illustration shows a stationary engine of the tandem compound type, which has been made for both heavy and light work. The special type is that manufactured by the Harrisburg Foundry & Machine Works, and to which they have given their name of the "Ideal" compound engine. In addition to the self-oiling feature, an arrangement which has been very successful in the simple engines built by the same Company, the compound has some additional points of interest. It is not a small simple engine compounded by adding a large low-pressure cylinder to it, nor are the high-pressure cylinder and connections hung on like an after-thought or makeshift, but it has been designed as a compound engine, and is a compact and serviceable machine. Special pains have been taken to make all the wearing parts accessible, and to make all bearings and wearing surfaces sufficient for the maximum power of the engine when condensing. In this engine it is not necessary to dismantle it to examine the low-pressure piston, but the intermediate connection is so constructed that the stuffing-boxes are accessible for adjustment or renewal of packing, and the low-pressure piston can be moved into the space between the cylinders for examination without breaking any other joints than the cylinder-heads.

In this engine, and all of the same class, the valves are worked by separate eccentrics. The high-pressure valve is controlled by the automatic governor, while the low-pressure eccentric is adjusted by hand for any desired cut-off in the large cylinder. The valve for the small cylinder is a solid piston-valve; in the large cylinder a patent adjustable valve is used, which is shown in fig. 2.

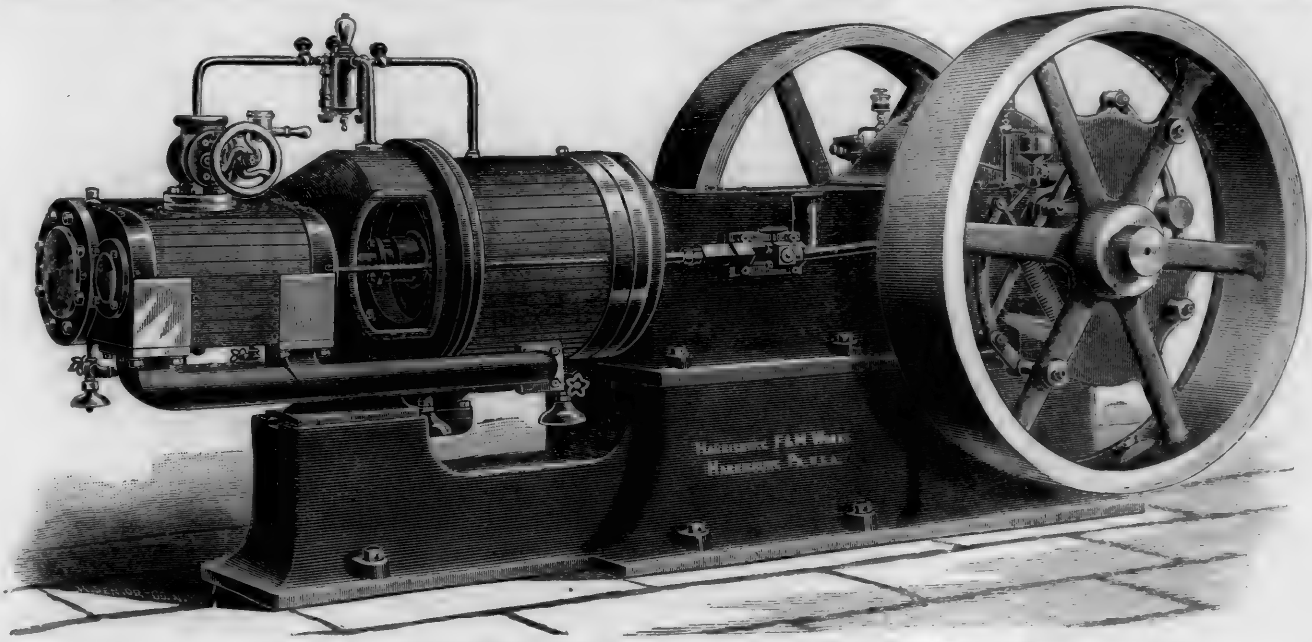
This patent adjustable valve was designed by M. E. Hershey, Manager of the Works, with the object of providing a piston-valve capable of rigid adjustment to compensate for wear, and a valve which will contract when the parts are cooled, preventing sticking or injury to wearing surfaces.

To accomplish this purpose an adjustable sectional spider is introduced, as shown in the cut, of composition metal or brass, having greater range of expansion than the metal in the valve proper or its seat. Live steam is admitted between the valve disks and the adjustment made when hot, the normal working condition. When steam is stopped off from the valve and the parts cool, the sectional brass spider contracts to a greater extent than the balance of the surrounding metals, and releases the packing rings, leaving them entirely free in their seats. When steam is admitted, the expansion of the spider being proportionately greater, the valves necessarily quickly assume their original adjustment.

It is the employment of the metals of varying expansibility that makes the positive valve adjustment practica-

ble. The brass spider, having the greater range of expansion, is so constructed as to be most susceptible to the change of temperature.

The general construction is shown in the cut; it will be observed that the peripheral adjustment to compensate

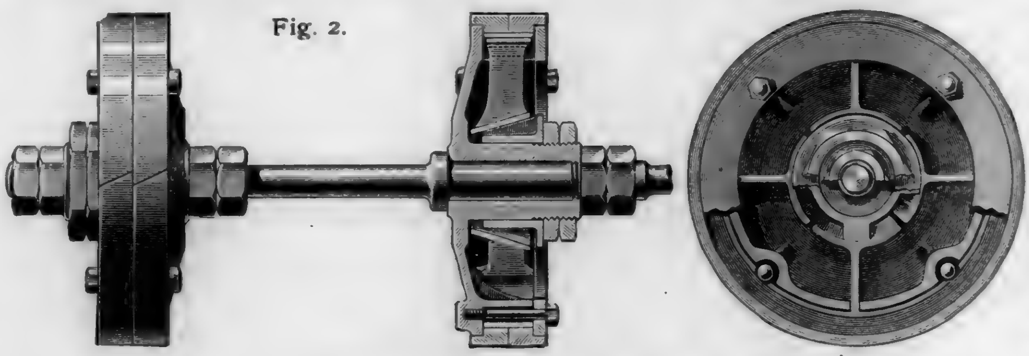


THE HARRISBURG IDEAL TANDEM COMPOUND ENGINE.

for wear does not affect any other adjustments for steam distribution.

The advantages claimed for this form of valve are that it is tight, balanced, and reduces the friction to a mini-

Fig. 2.



HERSHEY'S PISTON VALVE.

mum, while these conditions can be maintained to a greater degree than is possible with any other form of valve. The valve being light, the wear on the driving mechanism is reduced to a minimum and better regulation is attained with any form of governor, while, moreover, it can be adjusted without special mechanical skill or equipment. Experience has shown that with this valve the expense of maintenance is decreased.

LABOR LEADERS.

We reprint herewith, from the New York *Evening Post*, part of a lecture by M. Julien Weiler, of Morlanwelz, Belgium, who is widely known and respected in industrial circles throughout Belgium, and is an acknowledged authority on the labor question. He is at the head of the engineering department of the two great mining companies of Mariemont and Bascoup, and has been the means of establishing for both companies (which together employ more than 6,000 men) Boards of Conciliation and Arbitration, on which the companies and the workingmen are equally represented.

Mr. Weiler's lecture (delivered in 10 different cities of Belgium during the past three months) is entitled, "Industrial Conciliation and the Rôle of the Labor Leader." After explaining in the first part of the lecture what he means by industrial conciliation, the lecturer, in the second part, speaks as follows:

There is no doubt that this theory of industrial conciliation, based entirely upon confidence in the intelligence and moderation of both parties, will seem strange to those who, upon the authority of certain writers, think of employers only as men of unscrupulous greed, governed solely by a shameless love of money. It will also surprise others who regard workingmen as beings of ungovernable ferocity, whose unreasonable demands can only be met by force. These people would be still more surprised could they associate familiarly with the men whom they judge only by exceptions, had they the opportunity to learn how much benevolence there is among employers, and what patience among workingmen, whose efforts, in fact, are all aimed only at securing their rights.

But this brings me to another objection to the plan which I have explained to you. What sort of delegates will the workingmen send to these Boards? Is it not to be feared, if the elections are untrammelled, that it will be just the worst men in the shops? Those discontented fellows, always at the head of every disturbance, who want anything except peace, and of whom, therefore, it would be folly to expect anything useful? Well, yes, I should have to say to any one who asked me such questions, You certainly would have as delegates the very men whom you object to meeting. There is not the slightest doubt on that point, for everywhere where the experiment has been made, the elections have brought face to face on the Boards of Conciliation and Arbitration the men from both sides who hated each other the most.

But why did they hate each other? Because, up to that time, they had only known each other by the fighting qualities which had placed them at the head of their respective parties—because it was perfectly natural that each side should send to the Board the men who had given them proofs of their devotion, and because, naturally also,

LOCOMOTIVE RETURNS FOR THE MONTH OF MAY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	...	54	42,696	77,615	39,505	159,816	3,326	...	...	57.31	83.68	37.38	66.22	...	...	5.10	4.20	0.25	0.40	6.20	1.90	18.05	...	...	...
Alabama & Vicksburg	...	15	12,193	14,912	10,083	37,188	2,473	...	...	50.00	91.32	39.92	62.35	...	...	4.70	5.90	0.29	1.00	6.30	1.70	19.79	...	...	...
Atchison, Topeka & Santa Fé	834	733	...	...	370,136	2,258,730	3,081	...	...	...	...	...	73.23	...	...	3.67	5.79	0.28	0.11	6.65	1.31	17.81	...	...	1.48
Canadian Pacific	595	...	495,079	766,427	411,100	1,672,606	2,811	...	...	...	...	...	61.60	...	...	3.63	11.03	0.40	...	5.33	1.32	21.71	...	1.[illegible]7	3.54
Chic., Burlington & Quincy	518	...	...	...	...	1,744,585	3,368	4.98	17.75	...	...	...	83.02	...	...	5.00	5.71	0.29	0.22	6.48	...	17.79	...	...	1.35
Chic., Milwaukee & St. Paul	803	...	...	...	...	2,312,572	2,880	...	...	...	...	...	69.23	...	...	4.88	6.93	0.27	...	7.00	...	19.08	...	...	1.95
Chicago & Northwestern	862	...	683,951	1,318,538	798,031	2,800,520	3,249	...	...	...	...	...	79.08	...	...	3.36	7.04	0.36	...	6.32	0.86	17.94	...	...	1.76
Cincinnati Southern	...	103	81,921	174,422	86,215	342,558	3,326	...	...	60.79	110.49	43.76	82.64	...	...	4.30	5.20	0.27	0.50	6.50	1.60	18.37	...	...	...
Cleve., Cinn., Chic. & St. L.	...	426	423,151	559,690	264,905	1,349,746	3,168	4.60	21.50	94.70	102.25	68.82	87.07	15.61	6.91	3.12	5.52	0.2.	1.73	6.36	0.25	17.22	...	...	1.26
Cumberland & Penn.	...	20	5,772	27,419	...	33,191	1,660	...	...	...	...	...	85.47	...	...	6.06	4.60	0.40	...	...	2.00	13.06	...	...	...
Delaware, Lackawanna & W. Main L.	207	197	...	...	...	692,749	3,516	...	...	...	...	...	80.61	...	...	3.06	6.60	0.40	...	5.83	...	15.89	...	...	...
Morris & Essex Division.	154	...	166,350	248,321	12,981	427,652	2,777	...	...	...	...	...	59.75	...	...	4.31	9.42	0.36	...	6.19	...	20.28	...	...	...
Hannibal & St. Joseph	41	36	41,518	78,079	27,421	148,003	3,610	5.08	16.54	...	...	...	80.71	14.59	6.19	6.91	4.70	0.17	0.24	6.24	...	18.26	...	...	1.28
Kan. City, F. S. & Mem.	143	...	102,232	209,921	109,014	421,167	2,945	...	...	...	...	...	60.09	...	...	3.[illegible]5	5.01	0.20	0.46	7.35	...	16.[illegible]7	...	...	1.62
Kan. City, Mem. & Birm.	38	...	35,985	48,624	17,853	102,462	2,499	...	...	...	...	...	52.07	...	...	2.97	3.06	0.24	0.42	7.05	...	13.74	...	...	1.1[illegible]
Kan. City, St. Jo. & Council Bluffs	43	41	59,512	44,714	44,824	149,050	3,485	4.61	22.68	...	...	...	59.24	12.41	4.12	3.63	4.28	0.10	0.09	5.31	...	13.41	...	...	1.7[illegible]
Lake Shore & Mich. Southern	590	...	425,147	705,059	585,054	1,715,260	2,907	...	...	58.22	84.50	32.49	60.90	...	...	3.32	4.83	0.17	...	6.91	0.21	15.44	...	...	1.5[illegible]
Louisville & Nashville	...	*338	437,2[illegible]0	788,090	398,232	1,623,592	3,625	5.13	15.09	62.21	106.12	45.81	78.66	12.14	6.41	4.51	6.52	0.27	0.41	6.07	1.61	19.39	3.14	1.51	1.66
Manhattan Elevated	...	289	782,332	10,128	54,868	847,328	2,932	...	...	...	...	...	41.75	...	...	2.40	8.30	0.30	...	8.70	...	19.70	...	...	3.94
Mexican Central†	146	115	...	...	...	377,863	3,286	...	...	...	...	...	60.33	...	...	5.83	14.09	0.45	0.13	5.64	0.96	27.10	...	...	5.1[illegible]
Mil., L. S. & Western	112	101	76,840	156,362	110,585	343,787	3,404	...	...	...	...	...	72.26	...	...	3.08	10.80	0.24	...	6.14	0.93	21.19	...	...	3.[illegible]
Minn., St. P. & Sault Ste. Marie	...	...	65,399	119,484	38,851	223,734	...	4.80	16.44	...	...	...	53.10	...	...	3.95	9.15	0.20	...	6.30	...	19.60	...	1.[illegible]4	4.[illegible]7
Missouri Pacific	339	302	...	...	...	1,067,787	3,541	4.36	16.16	...	...	...	79.33	18.11	5.65	5.32	5.66	0.22	1.37	6.50	1.61	20.68	4.61	1.45	1.39
N. O. & Northeastern	...	28	29,976	43,052	21,482	94,510	3,375	...	...	60.79	106.38	34.81	76.63	...	...	6.80	7.30	0.28	0.60	6.20	1.70	22.88	...	...	...
N. Y., Chicago & St. Louis	138	136	39,673	356,079	142,753	538,325	3,958	3.70	24.10	...	...	...	86.96	13.62	4.65	3.00	7.20	...	0.30	6.50	...	17.00	4.60	0.70	...
N. Y., Lake Erie & Western	...	625	446,375	1,000,207	292,009	1,738,591	2,782	4.60	23.10	84.60	130.70	66.60	...	18.30	5.70	4.98	6.92	0.39	2.25	7.10	1.06	22.70	...	1.57	1.2[illegible]
N. Y., Pennsylvania & Ohio	...	262	139,241	418,178	137,744	695,163	2,653	5.50	18.10	68.90	121.50	70.50	...	12.50	6.70	4.08	5.87	0.31	1.95	6.71	1.01	19.93	...	1.66	1.15
N. Y., Prov. & Boston	...	92	108,993	52,320	57,116	218,429	2,374	...	...	...	...	...	50.01	...	...	3.40	9.63	0.53	...	6.41	1.26	21.23	...	...	...
Norfolk & Western, Gen. Eastern Div.‡	...	138	98,293	221,743	66,387	386,349	2,883	4.50	19.70	...	...	...	96.62	...	...	6.60	4.00	0.70	...	...	...	11.30	...	...	...
Durham Division‡	...	6	7,410	11,058	4,099	22,567	3,761	5.00	3.20	...	...	...	48.08	...	...	2.30	6.70	0.40	...	...	...	9.40	...	...	...
Radford Division‡	...	45	16,911	104,573	65,200	131,684	2,926	5.20	17.90	...	...	...	123.80	...	...	8.60	5.10	0.70	...	...	...	14.40	...	...	...
Pulaski Division‡	...	28	27,180	41,929	7,520	76,629	2,780	4.90	14.30	...	...	...	96.15	...	...	5.10	3.90	0.90	...	...	...	9.90	...	...	...
Clinch Valley Division‡	...	35	21,070	47,962	16,701	85,733	2,449	3.70	11.20	...	...	...	125.80	...	...	8.80	5.00	0.90	...	...	...	14.70	...	...	...
Winston-Salem Division‡	...	10	12,805	8,860	3,389	25,054	2,505	2.20	10.50	...	...	...	80.00	...	...	3.90	8.00	0.80	...	...	...	12.70	...	...	...
Old Colony	220	...	315,720	140,536	121,710	577,966	2,627	...	...	...	...	...	55.10	...	...	3.51	10.33	0.63	...	6.76	0.78	22.01	...	...	[illegible].75
Ohio and Mississippi	112	...	134,434	147,976	88,882	371,292	3,315	...	...	...	...	...	70.18	...	...	3.42	3.07	0.24	1.07	5.46	1.47	14.73	...	...	0.83
Philadelphia & Reading	...	...	455,967	712,447	514,538	1,682,952	...	...	...	...	...	...	82.88	...	...	4.77	4.61	0.31	...	5.81	0.42	15.92	...	...	...
South. Pacific, Pacific System	701	...	...	...	...	1,688,482	2,409	...	...	...	...	...	67.68	...	...	5.19	18.76	0.25	2.27	7.30	1.19	34.96	...	...	5.70
Union Pacific	995	...	689,085	1,162,287	477,559	2,328,931	2,341	5.73	16.22	...	...	...	98.28	14.92	8.10	6.99	9.84	0.43	0.94	8.03	1.18	27.41	4.52	2.10	[illegible].00
Vicksburg, S. & P.	...	13	10,502	10,202	10,341	31,045	2,388	...	...	46.08	71.43	23.34	49.02	...	...	3.20	6.70	0.27	0.90	6.50	2.60	20.17	...	...	...
Wabash	402	333	410,275	619,787	227,844	1,257,906	3,778	4.98	16.01	66.05	98.33	53.71	79.66	13.33	6.19	3.20	4.55	0.28	...	6.23	0.91	15.17	2.59	1.11	1.14
Wisconsin Central	152	125	130,217	212,624	72,278	413,119	3,305	...	...	...	...	...	75.73	...	...	3.09	9.18	0.24	...	7.21	...	19.72	...	...	2.36

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 17.9 units of work per $1 of expense; 181.3 units of work per ton of coal; 11.03 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

the leaders of hostile armies cannot have much affection for each other. We ourselves (I am speaking of the mining companies of Mariemont and Bascoup) had the disagreeable experience of receiving as delegates to the Board all those leaders whom we had only known by the very unflattering description we had heard of them, or by the exorbitant demands which had been reported to us as made by them. But, strangely enough, we had scarcely entered into relations with these men than we had to correct our impressions of them, for these terrible fellows turned out to be—not saints, of course—but men of intelligence and of the best intentions—men, that is, excellently fitted for the important duties required of them. The fact was that all their good qualities had been entirely hidden from us, while we had been looking at their faults under the microscope.

Having entered on this interesting subject, will you allow me a few moments to speak of the labor leader as I view him? I insist upon it that there are leaders and leaders, and I divide them into two classes, placing in the first the leaders belonging to the trade they represent, and in the second those who have no connection with the trade whose interests they undertake to defend. The leaders of the first class, those belonging to the craft they represent, I call *good leaders*. We shall see later whether the others can be called *bad*, and if so, to what degree? *Good leaders*, I say, and I call them so because they possess all the qualities which an employer can ask for in these indispensable mediators between himself and his employés.

An intelligent employer, instead of making their task more difficult, ought to do all in his power to help these leaders. To help the leaders? So far from that, a man has usually only to be the spokesman for his fellows in some request to their employer, in order to be accused of fomenting trouble in the shop and to be put on the black list.

I know of very few strikes which have not been followed by the discharge of the men forming the committees which led them, and even when these discharges do not take place at once and publicly, they take place just the same! Visit any shop or mine a few months after work has been resumed, and you will find but few of the leaders of the strike still at work. And then it is considered extremely ridiculous that the men, deprived of their natural leaders, turn to others, strangers to their craft, and of course less capable of leading them, but who, at least, are not in the power of their employers.

"Do you know," said one of the directors of a mine to me one day, shaking his head and shrugging his shoulders—"do you know what leaders my men have got now? A weaver from Verviers, a printer from Brussels, and a shoemaker from Charleroi! And," he added, "you want me to talk business with them?"

"Well," said I; "what have you done with the *miners* who led your last strike?" And I am still awaiting his answer. And these leaders are treated in this way, notwithstanding the fact (I am speaking of the leaders chosen by the workingmen from their own trade, not of the others) that they are usually the most intelligent, the most skilled, and the most courageous men to be found in the trade. Courageous, did I say? The word is not strong enough. They must have, besides courage, a spirit of self-sacrifice, or else mere foolhardiness, to dare to face the employers, after the many warnings they have had of the danger to themselves of such action.

But what are the qualities of a *good leader?* First, a complete knowledge of his craft, and consequently a perfect understanding of the conditions of the trade and its needs. Second, that he should have a personal stake in the trade, supplied by the fact that every change suggested by him will affect his own welfare and that of his family. The good leader is always a good workman, and often of exceptional skill; outsiders, coming from a distance, may influence the mass of workmen by other qualities, and succeed among them even if they know nothing of the trade, but he to whom the saying "A prophet is not without honor save in his own country," is especially applicable, cannot be chosen leader unless he gives proofs of his superior skill as a workman.

And these are the men whom employers, most unfortunately, make it a rule to discharge as soon as the respect of their fellow-workmen makes them prominent! And with what result? Simply to bring forward the *bad leaders!* The employers will not accept the leaders whose every circumstance is a guarantee of good faith and moderation, and they must therefore deal with those who offer no guarantee, for it is utterly impossible (as is proved by history) to effectually resist the force which is driving the workingmen toward their emancipation, and consequently to the use of all the means necessary to attain it.

And who are these other leaders, whom I will call *independent*, to distinguish them from the first? They are either men of education, but without experience in trade matters, and therefore unable to solve the problems to which they usually devote enthusiasm and talents which deserve a greater measure of success than they attain, or they belong to the class who have lost their natural place in life, such as are produced in all times of excitement.

I shall say nothing of the first, except to regret that our industrial customs, in putting them in the place of the natural leaders of the workingmen, divert them from other work which might be useful, and to declare emphatically that, although I condemn the sophistries by which they seek to lead astray the people of our towns, yet I believe their motives to be pure even if not unmixed with ambition.

But what of the leaders whom we may truly call *bad*, who fish in troubled waters, birds of ill-omen who fly to the scene of hostilities as soon as an industrial conflict is threatened? It would be difficult to feel toward them as kindly as toward the others, but is it not true that they would not exist if those whose places they take (the good leaders) had been treated differently? To begin with, where do they come from? I can tell you, at least as regards many of them. They come from the shops and the foundries and the mines from which they have been systematically driven whenever they have tried to act the part of good leaders—they are like cats whom fear has transformed into tigers—or rather like dogs, whom a merciless boycott has driven mad!

But if we ask how we can best make head against the cruel dynamiter, whether of hand or of tongue only, who in our day has attained to so sad a celebrity, I can only refer you to what I heard said by the Mayor of Ghent, that, if that important city had been saved from anarchy, it was due to the growth of a great labor organization.

I hope I have shown you that it is impossible to alienate the natural intermediaries between employers and employed, the natural leaders in all labor movements, without seeing their functions usurped by agitators, whose least defect it is that they furnish no guarantee of either intelligence or responsibility. There *must* be labor leaders! That is one of the conclusions of this lecture, and I hope that you consider that it is proved by the arguments I have presented to you.

COLUMBIAN EXPOSITION NOTES.

THE time officially set for receiving applications for space at the Exposition expired August 1. It is understood that requests for space can still be received, but late applicants will have to take their chances for admission, and cannot expect favorable positions.

A VERY curious exhibit will be made in the Transportation Department by the firm of Cook & Son, of London. It is intended to illustrate methods of traveling outside those ordinarily in use in civilized countries, and will include such means of transportation as the Norwegian carriole, Norwegian sleigh, Lapland dog sleigh, Irish car, Neapolitan cart, Turkish caique, Palestine encampment, camel saddle and harness, elephant with howdah, Bombay bullock cart, catamaran, Chinese palanquin, Japanese jinriksha, models of the dahabeahs or boats used on the Nile, and the like.

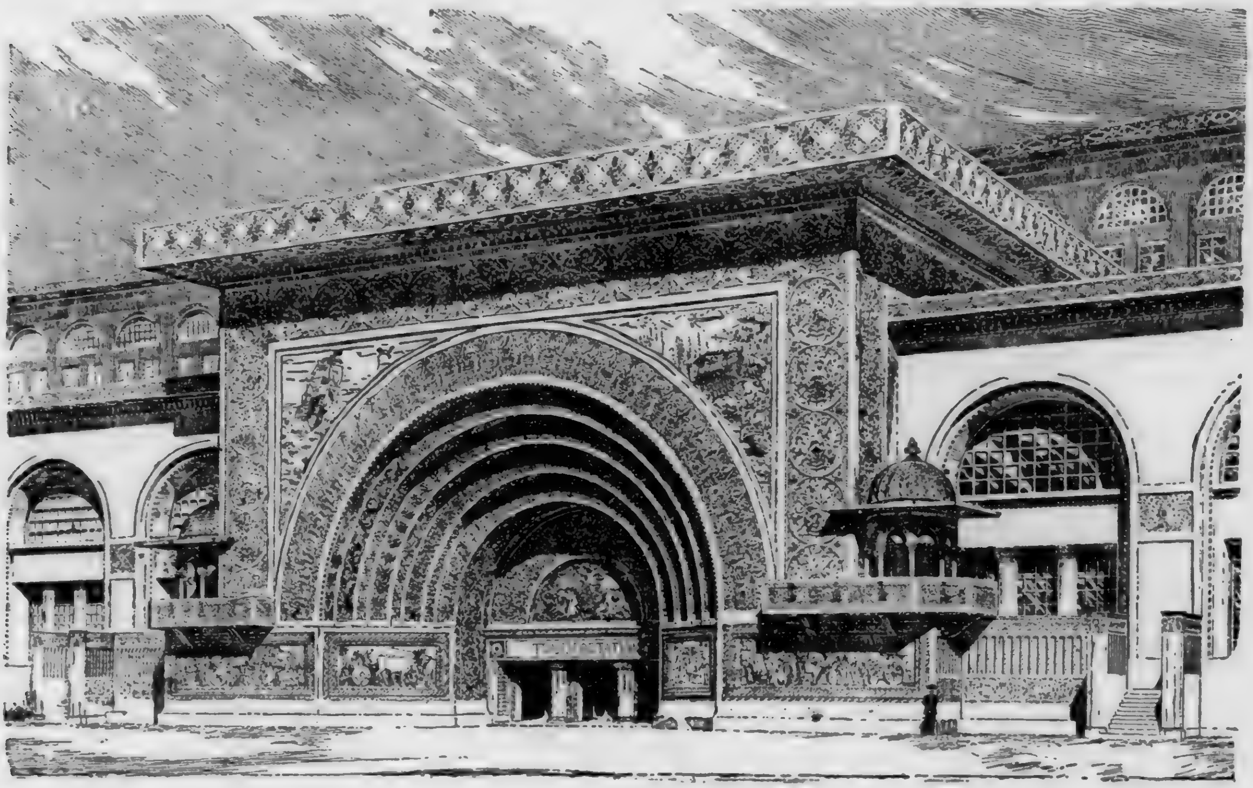
THE Chief of the Transportation Department, Mr. Willard A. Smith, has secured for exhibition one of the

boats used by the Canadian voyageurs, which he found in the State Historical Museum of Wisconsin, at Madison. The boat is an old batteau of the pattern used by the French-Canadian fur traders in their voyages on the lakes and rivers of the Northwest before Illinois or Wisconsin had been organized as territories. It is a leviathan of canoes, weighing 1,100 lbs., is 30 ft. long, and in its day carried 18 men and over a ton of goods for the Indian trade. Secretary Thwaite of the Wisconsin Historical Museum, on one of his canoe trips two years ago, found this relic, water-logged, on the banks of the Upper St. Croix, and had it conveyed to Madison.

THE Hoboken Land & Improvement Company will exhibit a fac-simile of the twin-screw steamer built in Hoboken by Mr. Stevens, in 1805. It will have the original boiler and engine, which have been preserved as relics. In connection with this the company will show a model of the *Hamburg*, the latest double-screw boat built for the ferry between Hoboken and New York.

THE accompanying illustration shows the most striking architectural feature of the Transportation Building — the "Golden Door." It will serve to give, even without the beautiful coloring which will characterize it in its completed state, a very good idea of what promises to be one of the most notable architectural features of this display. The dimensions of this door, as well as those of the building itself, have been so frequently published that it is useless to again reproduce them, but the accompanying sketch gives some idea of the general design and proportions.

IT is stated that the exhibit of the New York Central & Hudson River Railroad Company will include a reproduction of the first passenger train run on the old Mohawk & Hudson Railroad—the first beginning of the Central—which will be placed beside a complete train of vestibuled cars of the latest pattern.



THE "GOLDEN DOOR" OF THE TRANSPORTATION BUILDING, COLUMBIAN EXPOSITION.

Foreign Naval Notes.

A FRENCH COAST-DEFENSE SHIP.

THE cut given below, from *Le Yacht*, shows the armored coast-defense ship *Terrible* of the French Navy. This vessel is a heavily armored ship 280 ft. long, 59 ft. beam and 7,713 tons displacement; she carries two very heavy guns 42 cm. (16.5 in.) caliber; four 3.9-in. rapid-fire guns; two 1.85-in. rapid-fire guns and 16 revolving cannon and machine guns.

The illustration shows another instance of the tendency of the French designers to pile up structures upon the decks of their armored ships, which gives them a somewhat clumsy appearance.

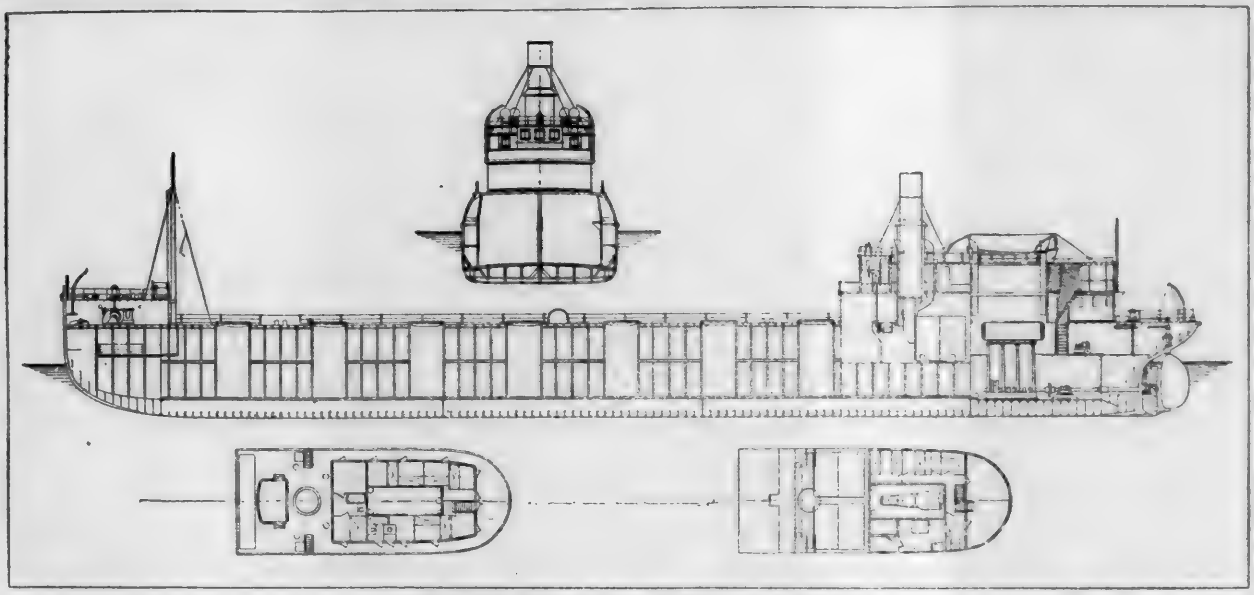
Lake Monitors.

THE first of the monitor type of cargo vessel, the *Andaste*, which has just taken 2,300 gross tons of iron ore from Escanaba on a draft of 14 ft. 10 in. forward and 15 ft. 2 in. aft, can be pronounced a successful carrier. On this draft—15 ft. even—the *Andaste's* cargo is full 150 tons greater than cargoes carried on the same draft by the *Wawatam* and *Griffin*, boats in the same fleet that are of similar dimensions but of the ordinary

HARBOR DEFENSE SHIP "TERRIBLE," FRENCH NAVY.

type of steel steamers. President Henry D. Coffinberry, of the Cleveland Ship Building Company, builders of the monitors, made the trip to Escanaba on the *Andaste*, and is very much pleased with the boat.

The accompanying illustration, made from drawings prepared just before the boat was launched, shows the monitor after several important changes in the original design. The second boat of this type, the *Choctaw*, is about ready for launching at the yard of the Cleveland Ship Building Company. The boat's dimensions are 266 ft. keel, 38 ft. beam and 23 ft. hold. The triple-expansion engines are 17, 29 and 47 in. × 36 in. stroke, getting steam from two 11 × 12-ft. boilers and turning an 11½-ft. wheel. The water bottom is 4½ ft. deep and is emptied and filled by a ballast pump with a 14-in. steam cylinder, 18-in. water cylinder and 12 in. stroke. The steam-steering gear can be worked by two wheels, one on the windlass house deck and the other from the pilot house aft.—*Cleveland Marine Review.*



THE LAKE CARGO STEAMER "ANDASTE."

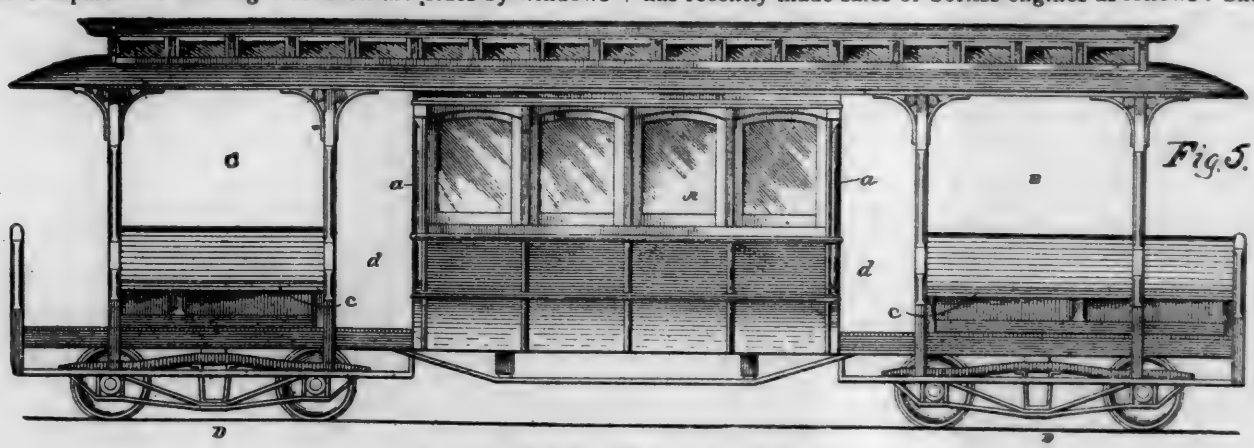
Recent Patents.

CABLE RAILROAD CAR.

Mr. John Hammond, of San Francisco, Cal., has patented the form of cable car shown in fig. 5, which he describes as follows:

The car is built with three compartments, *A*, *B* and *C*, the middle compartment *A* being closed on the sides by windows in the usual manner, and having a sliding door at each end, and a seat running lengthwise on each side of the car. The end compartments *B* and *C* are of open construction, being without windows or doors, and are provided with seats *c c*, running lengthwise of the car, as shown, and are placed back to back, with a sufficient space between the backs for working the cable-gripping mechanism. The entrances to compartment *A* are open at all times to the street by passages *d d d d*.

The symmetrical construction of this car adapts it for running in either direction, and greatly facilitates the handling at the terminus of the roadway, as the car is not turned around at this place; but by making a simple change in the gripping mechanism it is ready to commence the return trip. The open construction of the end compartments allows the gripman to have an unobstructed view ahead and on the sides. It will thus be seen that this car will run in either direction with equal facility. The appearance and construction of the car is the same at each end, being in fact a double combination-car.



HAMMOND'S CABLE RAILROAD CAR.

Manufactures.

General Notes.

The Jewett Supply Company will have early in September 60 passenger cars fitted with its anti-friction device on the Boston & Albany Railroad; this is a result of the excellent working of those already in use. The orders lately received are for the equipment of two full trains on the New York & Boston through line and the directors' car. Orders have also been received to equip some passenger cars for the Baltimore & Ohio and some cars for the Union Tank Line. The Boston & Albany intends to equip all its cars as fast as possible.

The Weisel & Victor Manufacturing Company, Milwaukee, has recently made sales of Corliss engines as follows: Sheboygan, Wis., Electric Company, one 46 × 48 in.; Mattoon Manufacturing Company, Sheboygan, Wis., one 46 × 42 in.; Cudahey Brothers, Milwaukee, one 20 × 42 in., one 22 × 42 in. and two 24 × 48 in.; Republican House, Milwaukee, one 14 × 36 in.; Opaque Cloth Company, Chicago, one 20 × 42 in.; Demme & Dierkes Furniture Company, Kankakee, Ill., one 26 × 48 in.; Heroy & Marrenner, Chicago Heights, one 10 × 30 in.; Milwaukee Malt & Grain Company, one 20 × 42 in.; Lembeck & Betz, Jersey City, N. J., one 22 × 42 in.; Swift & Company,

Chicago, one 18 × 42 in. high-pressure and one cross-compound, non-condensing, 24 and 34 × 48 in.; Chicago, Milwaukee & St. Paul Railroad Company, Milwaukee, one 500-H.P. cross-compound, condensing; Badger Illuminating Company, Milwaukee, one 600-H.P. cross-compound engine.

THE Irondale Steel & Iron Company, Anderson, Ind., has been reorganized, with George A. Laughlin, President; John T. Whitelaw, Vice-President, and H. O. Crane, General Manager. The works will be started up, and will shortly be enlarged.

THE Pennsylvania Railroad Company has completed and put on its ferry between New York and Jersey City the *Washington*, a new boat very similar to the *Cincinnati*, described some time ago, but with some improvements. The new boat has double screws, driven by two compound engines with Canfield's valve, as used in the *Cincinnati*; she is 206 ft. long, and 65 ft. wide over all. She is double-decked and very handsomely fitted up.

THE New Jersey Central Railroad Company has contracted with the Harlan & Hollingsworth Company, of Wilmington, Del., to build two double-screw ferry-boats 154 ft. long over all and 148 ft. on the water-line. These boats are to be double-decked and handsomely finished, with large passenger accommodations.

THE Union Pacific Company has recently placed a considerable order with the Falls Hollow Stay-bolt Company, Cuyahoga Falls, O., for hollow stay-bolt iron; and has also specified Falls Hollow stay-bolts to be used in several new locomotive boilers ordered from outside shops.

THE Pennell water purifier is to be put in at the water station at Bitter Creek on the Union Pacific. The water at that point is exceptionally bad, containing a very large proportion of alkali and various salts, and the company has had much trouble with the boilers on that division of the road.

HENRY C. GOULD has been chosen Vice-President and General Manager of the Gould Coupler Company, and F. P. HUNTLEY has been chosen Secretary of the Company.

An Embosssing Power Press.

THE illustration given herewith shows a power press used for embossing small work of various kinds, formerly done in drop presses, and which is adapted to a considerable range of work. This press, which is numbered 33 by the makers—the Ferracute Machine Company, of Bridgeton, N. J.—is the third in a series of four sizes used for this purpose.

It may be mentioned incidentally, as showing the extent of the press business, that the new catalogues of the Ferracute Company show over 150 sizes and kinds of presses for general sheet-metal work.

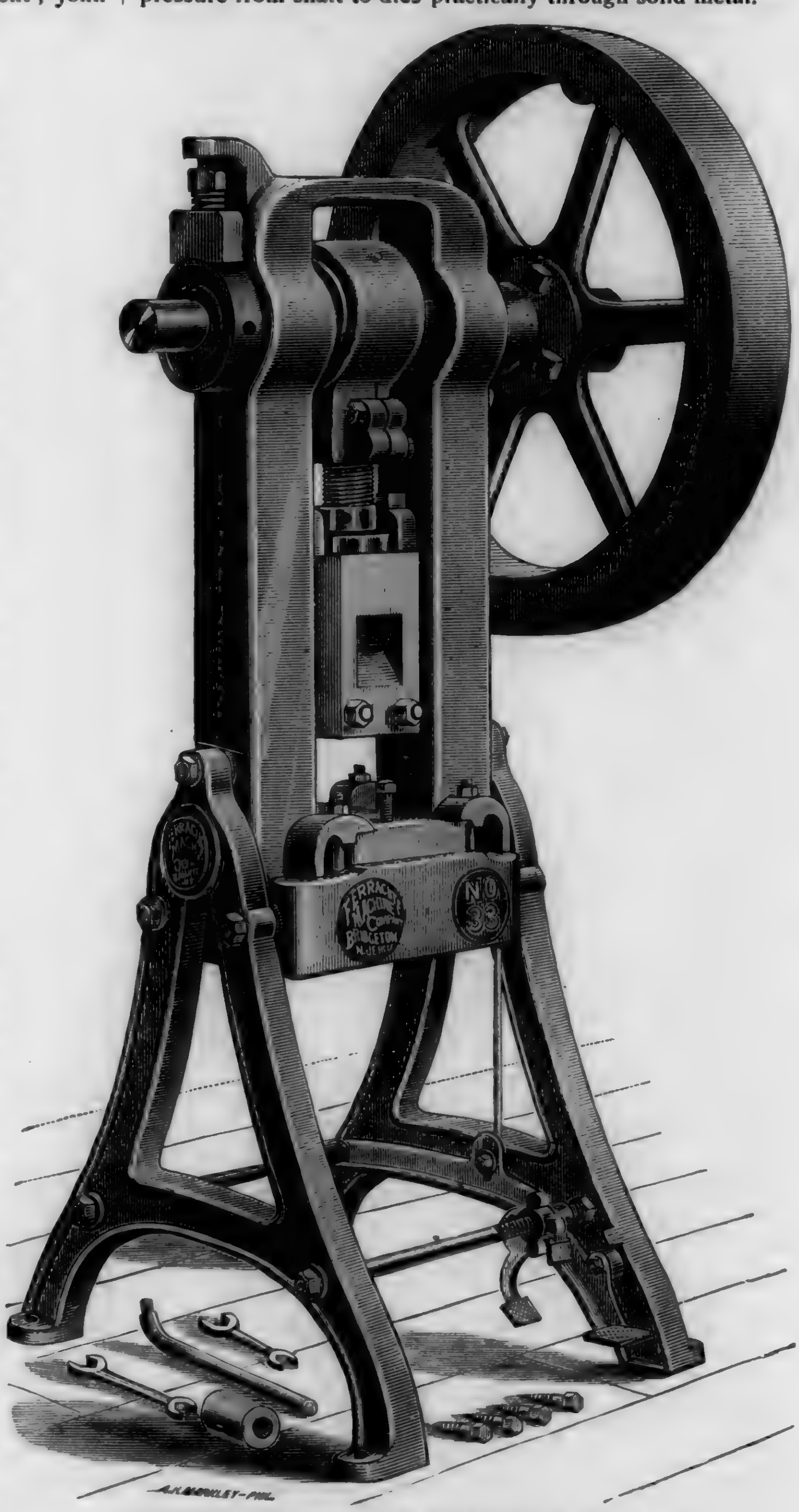
Returning to the press shown in the cut, it may be said that all of these presses have solid columns, not cored out hollow, and are built very heavy and substantial in their working parts. Among their peculiar features may be mentioned: 1. A new and improved automatic clutch, very simple and durable, and so arranged that the shaft cannot make more than one revolution by one action of the treadle. It consists of a lever or button connected with a sliding-pin in the shaft. This pin engages with studs projecting from the fly-wheel which runs loose on the shaft when out of action. There being three studs in the wheel, the operator never has to wait more than one-third of a revolution for the press to start. The wheel pins have square heads and can be revolved as they wear, thus giving greater life to the clutch than in other forms, and when worn out they are very cheaply replaced. This clutch is provided also with a safety-pin to lock it, allowing the shaft to be revolved to any position, and the dies adjusted while the fly-wheel is in motion, thus dispensing with the need of a counter-shaft.

2. A reversible treadle-lock operated by the foot, by which the treadle can be fastened down for continuous running, or up for safety when the press is temporarily stopped.

3. A treadle bumper and stop of India rubber for securing a noiseless and limited motion.

4. An adjustable spring-brake which controls the motion of the press and adapts it to various speeds.

5. An adjustable ball-and-socket pitman, provided with an improved clamping device at the upper end, thus avoiding the annoyance of loose joints incident to lock nuts, and giving the pressure from shaft to dies practically through solid metal.

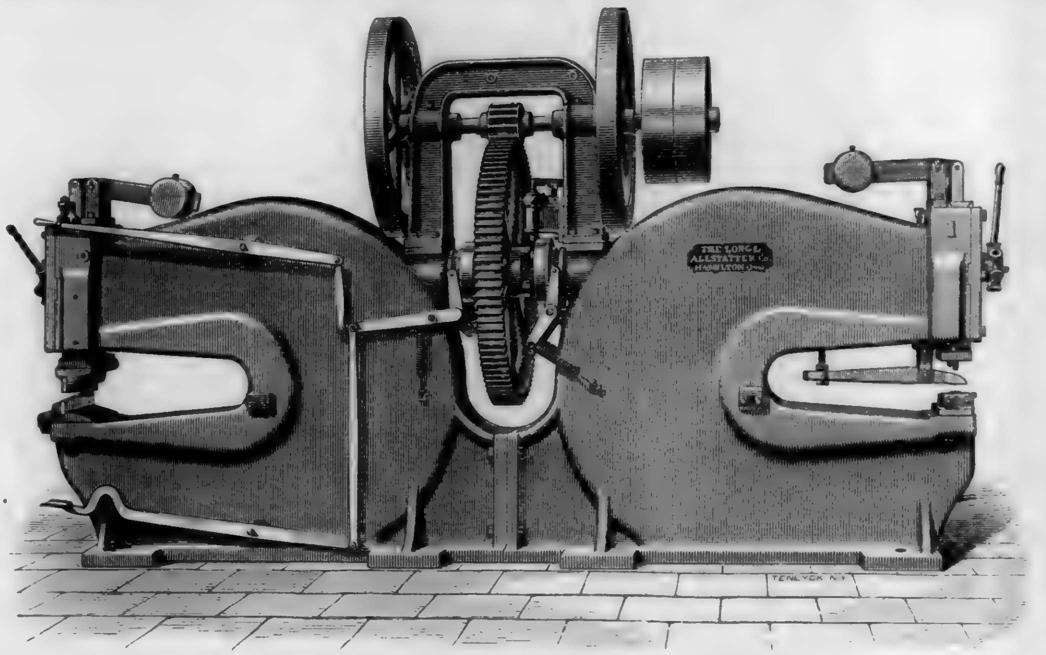


EMBOSSING PRESS BY THE FERRACUTE COMPANY.

The press is furnished with four die-clamps, the heads of the clamp-bolts sliding in slots in the bed. For some kinds of work two hook-headed clamps sliding in true bored holes are preferred, and these are furnished when ordered. The weight of press No. 33 is about 3,000 lbs.; weight of fly-wheel about 750 lbs.; diameter of fly-wheel, 39 in.; width of fly-wheel, 6 in.; stroke of slide-bar (variable to order), $1\frac{1}{4}$ in.; adjustment of slide-bar, 3 in.; size of each column, solid iron, $4\frac{1}{2} \times 7$ in.; breaking strain of columns about 2,500,000 lbs. The smallest size of this series weighs 1,000 lbs. and the largest 5,500 lbs. complete.

A Heavy Punching and Shearing Machine.

THE accompanying illustration shows a machine designed for general punching and shearing of iron and steel plate and for boiler work, which is made by the Long & Allstatter Company, of Hamilton, O. The machine is double, and both sides



HEAVY PUNCHING AND SHEARING MACHINE.

may be employed in punching or shearing, according to the tool with which it is fitted. The general advantage of the double machine, however, is that one side may always be ready for punching and the other side for shearing. Each side is entirely independent, and may be operated while the opposite side is at rest.

The machine is driven by a belt through powerful gearing turning steel cam shafts, and the latter may be turned by hand-gearing at the front of the machine to facilitate setting the tools. Where it is preferred to make the machine independent of a belt, it is provided with a double-acting steam-engine attached directly to it and designed for this special purpose. The slides are counterbalanced and the jaws are provided with convenient devices for the reception of the tools, punches, shearing belts, etc. The stripper is of convenient form and can be quickly removed.

The machine shown will punch holes up to $1\frac{1}{2}$ in. through 1-in. plates as far as 48 in. from the edge of the plate. It will also shear 1-in. plates. This machine is made with throats of equal depth, but where it is preferred they are made with unequal throats.

The machine illustrated is a type of a large number of similar class which are made by the same Company for special operations in punching and shearing, and which are adapted for work of different classes, while their general design and construction is the same as the one shown.

Lake Shipbuilding.

THE F. W. Wheeler yard at West Bay City, Mich., recently launched the *C. F. Bielman*, a sister ship to the *Uganda*, which was lately illustrated in the JOURNAL. This yard has lately closed contracts for a steel steamer for D. C. Whitney, of Detroit, to be a duplicate of the *W. H. Gilbert*, described below; also for two very large steel steamers for Hawgood & Avery, of Cleveland, to be 360 ft. keel, 377 ft. 6 in. over all, 45 ft. beam and 25 ft. molded depth. They will have a 54-in. water bottom and carry 1,350 tons of water ballast. The engines will be triple-expansion, cylinders 23 in., 37 in. and 62 in. × 44 in. The boilers will be of the Scotch type, 12 × $12\frac{1}{2}$ ft. The engines will be built in the Wheeler shops. Another contract is for a wooden schooner, 250 ft. keel, 41 ft. beam and 17 ft. molded depth.

The Globe Iron Works, Cleveland, have lately completed a large boat for the Minnesota Iron Company; she is 350 ft. long over all, 330 ft. keel, 45 ft. beam and 24 ft. 6 in. deep; the engines are triple-expansion, 24 in., 39 in. and 63 in. × 58 in., and there are three boilers.

Other large ships lately built are noted as follows:

Straightback, building by Detroit Dry Dock Company for Eddy Brothers, Saginaw: 360 ft. over all, 42 ft. beam and 24 ft. deep; engines same size as those of steamer *E. C. Pope*, which are 22, 35 and 56 × 44 in.

Pathfinder, building by the American Steel Barge Company, West Superior, Wis., for Samuel Mather, Cleveland, O.: 340 ft. over all, 325 ft. keel, 42 ft. beam and 25 ft. deep; engines 23, 37 and 62 in. × 42 in.; three boilers.

Monitor, building by the Cleveland Ship Building Company on their own account: 340 ft. over all, 324 ft. keel, 42 ft. beam and 24 ft. deep; engines 20, 33 and 54 in. × 40 in. stroke.

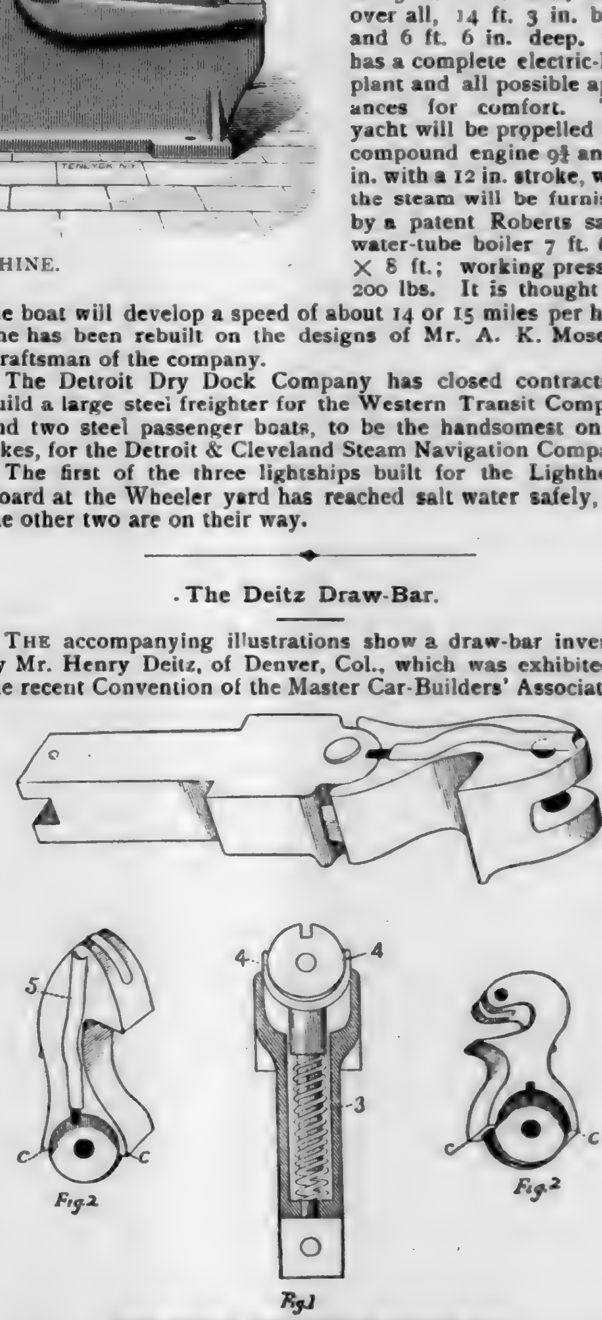
F. W. Wheeler & Company have lately completed the *Wapiti*, a very handsomely fitted yacht, rebuilt by Sibley & Bearinger. She is 83 ft. 6 in. keel, 86 ft. over all, 14 ft. 3 in. beam and 6 ft. 6 in. deep. She has a complete electric-light plant and all possible appliances for comfort. This yacht will be propelled by a compound engine $9\frac{1}{4}$ and 21 in. with a 12 in. stroke, while the steam will be furnished by a patent Roberts safety water-tube boiler 7 ft. 6 in. × 8 ft.; working pressure, 200 lbs. It is thought that the boat will develop a speed of about 14 or 15 miles per hour. She has been rebuilt on the designs of Mr. A. K. Moseley, Draftsman of the company.

The Detroit Dry Dock Company has closed contracts to build a large steel freighter for the Western Transit Company and two steel passenger boats, to be the handsomest on the lakes, for the Detroit & Cleveland Steam Navigation Company.

The first of the three lightships built for the Lighthouse Board at the Wheeler yard has reached salt water safely, and the other two are on their way.

The Deitz Draw-Bar.

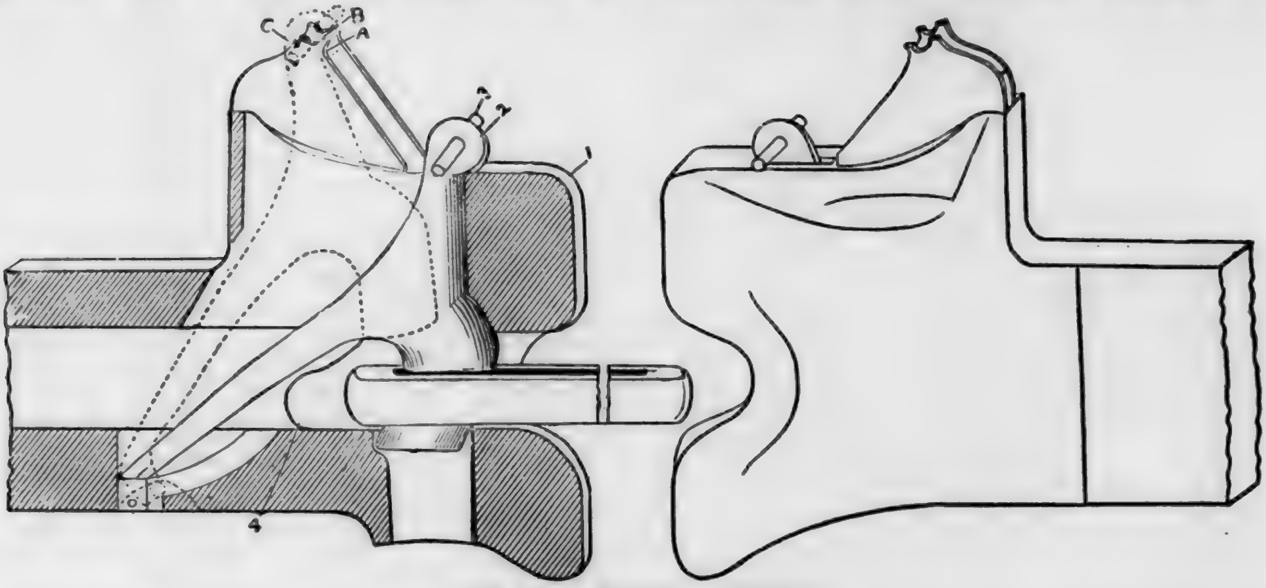
THE accompanying illustrations show a draw-bar invented by Mr. Henry Deitz, of Denver, Col., which was exhibited at the recent Convention of the Master Car-Builders' Association.



THE DEITZ PASSENGER DRAW-BAR.

The first illustration, figs. 1 and 2, shows Mr. Deitz's passenger draw-bar, which is intended to use a head of either the Miller or the M. C. B. type. The change can be made, as will be

seen from the drawings, by simply taking the pin out and substituting a new hook for the one previously in use and then replacing the pin, so that the change can be quickly made from



THE DEITZ FREIGHT COUPLER.

one form of head to the other. The advantages claimed are that cars in this way can be interchanged without difficulty where a different type of drawhead is used.

The freight coupler, which is shown in fig. 3, is a link-and-pin coupler, which, the inventor claims, is automatic and will not cause any difficulty in coupling on sharp curves. The key-hook is so shaped that if the link is pushed in while the hook is at its normal position it rises automatically and drops back into position, locking the coupler, while if the link has been previously inserted it can be dropped out or be lost. The drawing shows the arrangement sufficiently well, 1 being the draw-bar, 2 the key-hook, 3 hand-rod for uncoupling, and 4 the link-holder, while *A* shows the step, *B* the chair, and *C* the back of the chair. This can readily be worked from the side of the car by means of a rod and lever with a handle on the end. This coupler, we are informed, is to be tried on several roads.

A New Gate Valve.

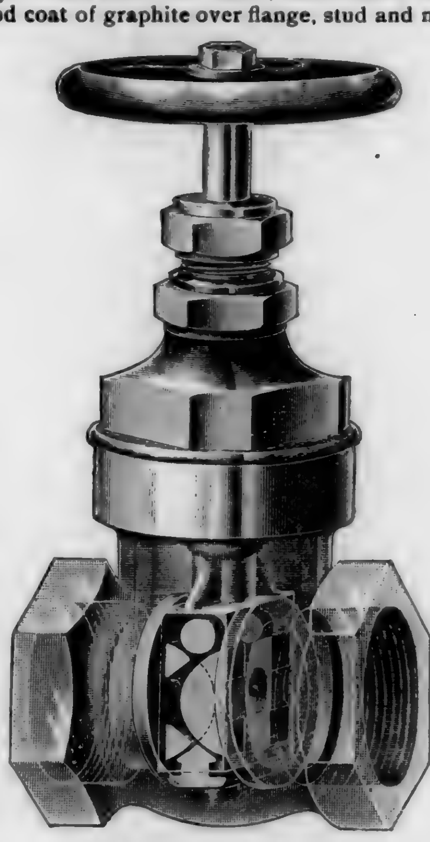
THE illustration given herewith shows a new pattern of gate valve, to which the manufacturers have given the name of the "mobile wedge" valve; it is made by the Ross Valve Company, of Troy, N. Y.

The distinguishing feature in this valve is the rolling action of the movable wedge, which secures a uniform pressure over the entire back of the gate; this is accomplished without any grinding of the valve faces by sliding contact. The mechanism consists of two pairs of X-shaped bearing blocks carrying a rolling wedge between them, and a seating plunger which bears in the center of the valve case when the valve is closed, as shown in the engraving. The pressure to seat the valve is equally divided between four points on each disk or gate, and a positive motion seats them without sliding them on their faces. Each gate is hung on trunnions and is free to revolve, so that it is seated in a different place each time the gate is operated; an arrangement which will evidently tend to keep the valve tight and prolong its life.

It is claimed that this valve is much more easily operated than the ordinary gate valve, especially in the larger sizes. It has given satisfaction wherever it has been used.

Other Uses for Graphite.

A CORRESPONDENT says: "I have read an article on graphite taken from the *American Machinist*. Let me say that I have used graphite for many purposes, some that the correspondent did not name, which I will give as it may benefit some of my brother engineers, who perhaps have not experimented to any great extent with the article. I have used handhole and manhole gaskets eight to ten times by carefully smearing the surface next boiler shell, taken out at periods of three to four weeks, using steam pressure as high as 100 lbs. In packing water glasses, by putting a little graphite and oil on the gasket they would vulcanize as soft as lamp-wick and retain their elasticity until the glass was changed, when the old rubber could be removed without trouble, while by the old way, I have spent much time in digging out the rubber, baked hard as vulcanite. Another thing I used it for was after putting back my handhole plate or plugs in back connection, I carefully brush away all the soot and ashes, then with a small brush paint a good coat of graphite over flange, stud and nuts. After



THE ROSS GATE VALVE.

running boiler from three to six months, and using coke for fuel, with forced draft, the nuts can be removed without trouble, as the heat has not been great enough to burn the lead."

Baltimore Notes.

MESSRS. JAMES E. HEWES & WILLIAM BROWNE, JR., Electric Engineers, have submitted a proposition to the Mayor and City Council to light the city by electricity. The proposition contemplates the utilization of the large overflow of Lock Raven Dam. The capacity of the plant is given at 500 H.P., but can easily be increased. The turbines proposed to be used

are the Poole and Hunt-Leffel type, and the dynamos of the Edison type.

THE Curtis Bay Electric Railroad Company is double tracking its line between Curtis Bay and Baltimore.

THE Pullman Company is building 300 gondola cars for the Columbus & Hocking Valley Coal & Iron Company.

THE construction of a boulevard between Baltimore and Washington, which has been discussed for a long time, is said to be approaching a practical stage. With the boulevard a traction system is said to be linked. About all the necessary legislation to enable the plans to be successfully completed has been passed, and men with ample capital to carry out the idea are said to have taken hold of the enterprise, which is now backed by the capitalists of the Baltimore Traction Company. In the session of the Maryland Legislature last winter, an act which was approved April 7 was passed, incorporating the Baltimore & Washington Turnpike & Tramway Company. The incorporators named included a number of well-known persons living along the route of the proposed road. A few days after the approval of the act the subscription books were opened at Laurel, under the provisions of the act, and all the stock was subscribed, a majority of the subscriptions being taken in the interest of the Baltimore Traction Company. Immediate action in the building of the road was prevented, it is said, on account of the inability to complete the road farther than the northeastern line of the District of Columbia, as the charter from the Maryland Legislature could only empower the building of the line to that point. A bill was pushed through Congress, and approved recently, which provides for the necessary link of the road within the District of Columbia. One of the directors states that the boulevard will undoubtedly be built. The absence of many of the directors from the city at present will probably cause a delay in the commencement of active operations until fall, he added, but by the latter part of September a meeting will probably be held and the work laid out. No details of the constructions have been arranged, and it is said the necessary surveys have not been made. It is said electricity will be the motive power on the tramway.

THE General Manager, J. T. Odell, of the Baltimore & Ohio Railroad, has just completed an inspection trip over the Grafton & Greenbrier Railroad. This road has recently been acquired by the Baltimore & Ohio, and its name has been changed to the Grafton & Bealington Railroad. It was formerly operated as a narrow-gauge line, but has been changed to standard gauge by the Baltimore & Ohio. The Grafton & Bealington is 42 miles long, and extends eastwardly from Grafton. The West Virginia Central Railroad Company has built a connecting link, 16 miles long, from Elkins, on its main line, to Bealington, where a connection is made with the new link of the Baltimore & Ohio. An agreement has been entered into between the Baltimore & Ohio and the West Virginia Central for an interchange of freight traffic in a few days. By the completion of these links the West Virginia Central will have direct communication with the leading trunk lines East and West, and the Baltimore & Ohio will secure a share of the valuable coal, coke and lumber traffic of West Virginia, which has its outlet over the West Virginia Central. The extension and enlargement of the two roads will give the iron fields of Northern Virginia, the coal, timber, and ore fields of West Virginia, and the Pennsylvania forests adjacent a short connection to the trunk lines, so that they can be more easily reached from all points East and West. Much of this traffic has heretofore taken a circuitous route to reach its destination.

THE Baltimore & Ohio Southwestern has ordered 20 side-dump cars from the Pullman Company.

THE Carlisle Manufacturing Company is just completing an order of 300 cars for the Monongahela River Railroad, and is also about to build 100 each for the Fairmount Coal & Coke Company and the Gaston Coal Company.

THE South Baltimore Car Works will build 100 cars for the West Virginia & Pittsburgh Railroad for the logging trade. They will be flat cars, especially strong, and with 30-in. wheels.

Car Lighting.

THE Midland Railway of England has adopted the Pintsch light as the standard method of illuminating its passenger cars. The company has already caused the erection of three gas plants at various points along the line, and has ordered equipment for 886 cars. This company has abandoned the use of the electric system of lighting which it has had in use for several years, as it was found to be expensive and unreliable for service; and after due consideration it has taken up the Pintsch system as being the cleanest, safest and most economical method of car lighting.

The Servé Ribbed Boiler Tube.

SOME reference has heretofore been made to the Servé ribbed boiler tube, and the advantages which it offers of increasing the heating surface of boilers, with a corresponding economy of fuel.

Recent orders for marine boilers include sets of tubes for a steamer of the Allan transatlantic line, and one for the Cunard line. These tubes are now in use on the new steamer *Mascotte* of the Plant line, running between Port Tampa and Havana.

For locomotives the first company to adopt these tubes was

SECTION OF A SERVÉ RIBBED BOILER TUBE.

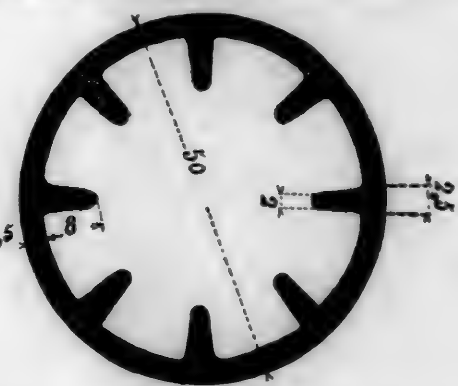


Fig. 1.

the Paris, Lyons & Mediterranean in France; on that road 100 locomotive boilers are fitted with them, and have done so well that 100 more sets were recently ordered. They are also in use on the Great Eastern in England.

In this country ribbed tubes are in use on the Grand Trunk in Canada, and experimental sets have lately been ordered by the Canadian Pacific, the Mexican Central, the Southern Pacific and the Pennsylvania Railroad.

PERSONALS.

H. H. GLADDING has been appointed Assistant City Engineer of New Haven, Conn., succeeding J. S. MORLEY resigned.

THOMAS HASSARD, for 10 years past Engineer in the office of the United States Commissioner of Railroads, has resigned on account of continued ill health.

C. G. WALDO has been appointed Assistant to the President of the Cincinnati, Hamilton & Dayton Railroad Company, and GEORGE R. BALCH has been made Purchasing Agent of the same company.

J. O. PATTEE, for some time past Master Mechanic of the Great Northern Railroad, has been appointed Superintendent of Motive Power of the Great Northern and all its controlled and proprietary lines.

RICHARD RELF, of St. Paul, Minn., has been appointed Engineer in the office of the United States Commissioner of Railroads. Mr. Relf has been for many years connected with the Northern Pacific Railroad.

CHARLES C. MORRISON, formerly President of the Columbia Bridge Company, of Dayton, O., has opened an office in Milwaukee as Consulting Bridge Engineer. He will also represent the Lafayette Bridge Company.

COLONEL CARY A. WILSON has been appointed Chief Engineer of Maintenance of Way on the Missouri, Kansas & Texas Railroad. He was formerly Chief Engineer of the East Tennessee, Virginia & Georgia Railroad.

LOUIS COSTE has been appointed Chief Engineer of Public Works of the Dominion Government. He has filled the position for about a year under a temporary appointment, and, although still a young man, has had charge of many important works.

OBITUARIES.

COLONEL HENRY CLAY NUTT, who died in Chicago, August 15, aged 59 years, was born in Montpelier, Vt. As a boy he found employment on the Vermont & Canada Railroad, and later was successively a rodman, assistant engineer and conductor on the Plattsburg & Montreal Railroad. From 1851 to 1855 he was Chief Engineer of construction and location of the Peoria & Oquawka Railroad (now part of the Chicago, Burling-

ton & Quincy), and from 1857 to 1860 was Chief Engineer of the Council Bluffs & St. Joseph road; afterward he was a general steamship, express and railroad agent in Chicago. In 1881 he went to Boston to accept the presidency of the Atlantic & Pacific Railroad. In consequence of ill health Colonel Nutt found it necessary in 1889 to resign, and returned to Chicago to live.

BENJAMIN G. CLARKE, who died in Antwerp, August 12, aged 72 years, had been for many years a leading man in the iron trade. He was born in Easton, Pa., and was brought up to the iron business, in which he was engaged from his boyhood. He had been for some time in failing health, and at the time of his death was on his way to Hombourg in Germany for medical treatment. For the last 20 years he had been President of the Thomas Iron Company. He was also President of the New Jersey Zinc & Iron Company; Chairman of the Lackawanna Iron & Steel Company; President of the Lackawanna Coal Company and a director in the Delaware, Lackawanna & Western Railroad. He was a member of several clubs and associations, and was well known socially as well as in business.

HUGH RIDDLE, who died in Chicago, August 10, aged 70 years, was born at Bedford, N. Y., and at an early age found employment in an engineer corps on the Erie Railroad. With the exception of two years on the old Buffalo & State Line road, he remained with the Erie until 1869, rising through various grades to the position of General Superintendent. In 1869 he went to Chicago as General Superintendent of the Chicago, Rock Island & Pacific Railroad. In 1871 he became Vice-President of that company and in 1877 he was elected President, serving in that capacity until 1883. He was associated with Charles Francis Adams on the Trunk Line Committee in 1884, and in 1885 he was elected a director of the Union Pacific. Some years ago he retired from active work, and has since lived quietly in Chicago.

GENERAL WILLIAM PETIT TROWBRIDGE, for 16 years Professor of Engineering in the School of Mines in Columbia College, New York, died suddenly in New Haven, Conn., August 12, aged 64 years. He was born in Oakland County, Mich.; at 16 he secured the appointment to the Military Academy, West Point, from his district, and was graduated at the head of his class in 1848. He was assigned to the Engineer Corps and was made a first lieutenant in 1854. In his last year at the Academy, although he was but 19 years old, he acted as assistant professor of chemistry, and for two years after that took a special course in the astronomical observatory there, fitting himself for service in the Coast Survey, to which he had asked to be assigned. In 1852 he took charge of the triangulation of the coast of Maine, and the following year he was sent to the Pacific Coast, where he remained until 1856 making tidal and magnetic observations. He resigned in December of that year to take the chair of mathematics in the University of Michigan, but a year later went back as permanent assistant in the Coast Survey. When the war broke out General Trowbridge was placed in charge of the engineer office in New York City, where he looked after the supply of materials for fortifications and the construction and shipping of supplies to engineers in the field. He superintended the engineering at the building of the fort at Willett's Point and the repairs on Fort Schuyler and Governor's Island. In 1865 he became Vice-President of the Novelty Iron Works, and remained there for four years, when he was elected Professor of Dynamical Engineering at Yale. In 1876 he went to Columbia to succeed General Vinton in the engineering chair.

He was Adjutant-General of the State of Connecticut on Governor Ingersoll's staff from 1873 to 1876, and held a number of State offices. Degrees were conferred on him by Rochester, Yale, Princeton, Trinity and the University of Michigan. General Trowbridge was a member of the National Academy of Sciences and presided over the American Association meeting in 1882. He published a number of books on engineering, but was most famous as the man who first suggested the idea of the cantilever bridge.

PROCEEDINGS OF SOCIETIES.

Master Car and Locomotive Painters' Association.—The Secretary, Mr. Robert McKeon, has issued notice of the Annual Convention, which will be held in Detroit, Mich., beginning at 10 A.M., September 14. The headquarters will be at the Russell House, where special arrangements have been made for delegates, with the uniform rate of $3 per day. An invitation is extended to all foremen car and locomotive painters to attend and to become members of the Association.

At the last Convention Committees were appointed to report upon the following questions:

1. Would it be practicable for railroad companies to adopt the piece-price system in the Paint Department; if so, what plan and schedule can be suggested for doing the work so as to cover all classes of paint-shop work upon locomotives and cars?

2. What is the best method of making putty for passenger-car work? Is it advisable to use any coloring with lead in mixing hard-drying putty?

3. In what manner should the outside surface of a passenger car be treated that has a good foundation but requires recovering? Should the varnish be removed before recovering?

4. What can be done by members of this Association to make it of greater benefit to Master Painters and the companies which they represent?

5. The advantages, if any, which might accrue to the members of this Association from the appointment of a standing Arbitration Committee.

6. Requisitions for material in the railroad paint shop. How should they be made?

7. Which are the most durable light or dark colors on passenger car bodies? Which is the least expense to maintain, yellow, Pullman color or Tuscan red?

8. By our experience as Master Painters, are we satisfied that passenger cars are receiving proper care at terminals? What plan and material can we recommend to improve upon the general appearance of the equipment while in service, and also increase its durability?

9. What is the difference in cost of painting a passenger coach with yellow, Pullman color or Tuscan red?

In addition to these reports to be submitted by committees, the following queries will be presented to the Convention for general discussion:

1. Do you paint your engine frames with color and then varnish them, or do you use asphaltum?

2. How do you clean the paint and varnish from glass?

3. In touching up and revarnishing a coach is it economy to thoroughly clean and touch up the deck and trucks, or to paint them over?

4. How do you use gold and copper bronze for seat arms, heater pipes, etc., dry or mixed?

5. Which is the best gilding size, slow or quick?

6. In cutting in a coach with color, do you use it mixed in the same way as when giving a general painting?

7. Do you give the sashes the last coat of varnish before or after they are put in?

8. Has any member ever found a paint remover that he felt sure would not injure the wood or subsequent painting?

Master Mechanics' Association.—A circular from Secretary Angus Sinclair announces the subjects for discussion and the Committees for the current year as follows:

EXHAUST PIPES, NOZZLES AND STEAM PASSAGES.—C. F. Thomas, A. W. Gibbs, S. Higgins, J. M. Wallis, George W. Smith, Robert Quayle, John Y. Smith.

STANDARD TESTS FOR LOCOMOTIVES.—To investigate the practicability of establishing a standard system of tests to demonstrate the fuel and water consumption of locomotive. Also to ascertain the value of the steam-engine indicator in locomotive tests. J. N. Lauder, W. J. Robertson, Albert Griggs, John D. Campbell, F. W. Dean.

COMPOUND LOCOMOTIVES.—To investigate the relative economy of compound and simple locomotives; also the most valuable form of compound locomotives. George Gibbs, William H. Lewis, Pulaski Leeds, James Meehan, T. W. Gentry, A. T. Woods. Auxiliary Committee.—S. M. Vauclain, Baldwin Locomotive Works; Reuben Wells, Rogers Locomotive Works; H. N. Sprague, Porter Locomotive Works; A. J. Pitkin, Schenectady Locomotive Works; Joseph Lythgoe, Rhode Island Locomotive Works; F. J. Leigh, Canadian Locomotive Works; D. A. Wightman, Pittsburgh Locomotive Works; H. Tandy, Brooks Locomotive Works.

TESTS OF IRON AND STEEL.—To test the critical temperature of iron and steel; also any other questions relating to steel and iron that the Committee may consider of value. William Smith, J. N. Barr, A. W. Quackenbush, P. H. Peck, D. L. Barnes.

UNIFORM LOCOMOTIVE PERFORMANCE SHEETS.—To report on the practicability of establishing a system of recording the performance of locomotives that will fairly represent the work done. George F. Wilson, J. S. McCrum, John Player, James McNaughton, John A. Hill.

STANDARD DIAMETERS FOR WHEEL-CENTERS AND TIRES.—

To report on Dimensions of wheel-centers for driving-wheels larger than the standard; also to investigate the means of securing uniformity in rolled outline of standard tires. A. E. Mitchell, W. C. Ennis, Thomas Millen, C. A. Thompson, L. R. Pomeroy.

BOILER ATTACHMENTS.—How can the safety of these be increased and how can the number of holes in a boiler be lessened? James Macbeth, A. Dolbeer, J. M. Boon, W. A. Foster, M. N. Forney.

MALLEABLE IRON CASTINGS.—To what extent can these be used to take the place of expensive forgings? R. H. Soule, W. Garstang, W. H. Thomas, C. H. Cory, W. D. Crossman.

ATTACHMENTS BETWEEN ENGINE AND TENDER.—Suggest improved form that will prevent the tendency for the tender to mount the foot-plate; also to report on foot-steps and hand-rails. J. Davis Barnett, G. W. Stevens, C. E. Smart, W. S. Morris, L. S. Randolph, L. F. Lyne.

SMOKE PREVENTION.—Recommend methods of smoke prevention that will satisfy municipal requirements in cities. J. N. Barr, F. Mertsheimer, P. W. Gentry, William McIntosh, W. H. Marshall.

TENDER FRAMES.—Reports on best form of tender and truck frames of wood and iron. R. C. Blackall, E. E. Davis, John Mackenzie, T. Purves, Jr., F. B. Miles.

OBITUARY NOTICES.—Subject and Committee: Ross Kells—Leroy Kells; William F. Turreff—William Fuller; Joseph Brandt—A. Dolbeer; S. D. Bradley—J. E. Keegan; Edward Nichols—M. L. Hinman; William Smith—E. E. Davis; William Wilson—A. Quackenbush; O. A. Haynes—H. Elliot; James Sedgley—G. A. Stevens.

APPLICATIONS FOR ASSOCIATE MEMBERSHIP.—George H. Baker—Committee, J. N. Lauder, William Swanston, R. H. Briggs. John H. Leeds—O. Stewart, J. D. Campbell, F. W. Twombly. H. P. Robinson—J. N. Barr, G. F. Wilson, Peter H. Peck.

SUBJECTS FOR INVESTIGATION.—George Gibbs, William Smith, E. M. Roberts.

DELEGATES TO CONVENTION OF AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.—J. N. Lauder, John Mackenzie.

EXECUTIVE COMMITTEE.—John Hickey, R. C. Blackall, William Garstang, O. Stewart, Angus Sinc air.

Southern & Southwestern Railroad Club.—A meeting was held at the Kimball House, Atlanta, Ga., August 18. Committee reports were made on Repair Work on Large Systems and the Best Location of Plants and on the Best Form of Performance Sheet. There were three subjects for discussion, the first being Joint Inspection, the second—a closely allied one—Charges for Material in Freight-Car Repairs, and the third, the Effect of Wear on Locomotive Cylinders from Piston Packing.

Virginia Association of Engineers.—The regular meeting was held in Richmond, Va., July 4 and 5. The meeting was opened by the annual address of President Clarence Coleman.

The following new members were elected: Frank Backman, William G. Brown, Julian R. Downman, J. H. Dunstan, Samuel G. Gaillard, James S. Green, James C. Meen, John T. Morgan, Walter L. Patterson, Archibald L. Sproul, William B. Stephens. In addition Colonel E. T. D. Myers was elected an honorary member.

The reports of the Secretary and Treasurer, covering six months' work, were received.

The Committee on Highway Improvement presented a report of progress, and was continued. The report on this subject will be a leading topic for discussion at the next meeting.

The following papers were read at the meeting: Necessity of Co-operation among Engineers, T. W. M. Draper; A National Railroad College, Herman Coneger; Easement Curves, Charles H. Rice; Need of a Weather and Signal Station at Roanoke, Charles H. Churchill; The Iron Pier at Lambert's Point, W. W. Coe; Work of the First Mining Engineer in the Colony of Virginia, W. H. Adams.

Technical Society of the Pacific Coast.—At the regular meeting, August 5, Mr. John Pitchford read a paper on the Corliss Engine. This was followed by one on Hydraulic Passenger Elevators, by Horace B. Gale, and Lieutenant John D. Finley made some remarks on the general circulation of the atmosphere.

Engineers' Club of Cincinnati.—There was a very good attendance at the June meeting of the Club.

The subject, "What to do with Mill Creek and its Valleys," was taken up and discussed by Colonel W. L. Robinson in a short paper on the subject, advocating the filling of the valley for a certain distance, and appropriating the same for railroad yards and terminals, reserving space for the passage of the creek. Its use for a harbor of refuge for steamboats and as a terminal for a ship canal, to be made by enlarging the Miami Canal, was also advocated by some. The valley is being slowly filled as new streets are made and improvements established within its limits, but no definite action looking to its ultimate availability has ever been taken. The valley within the city limits proper is a mile or more in length and half a mile or more in width, and from 20 to 40 ft. below the established grade of the streets in that vicinity, and the question as to the ultimate use to which it would be put has been and is a problem requiring for any purpose the expenditure of millions of dollars and years of time.

NOTES AND NEWS.

Bridging the Bosphorus.—A commission has been appointed by the Turkish Government to consider a project for building a bridge across the Bosphorus from Stamboul to Scutari. The proposed bridge is to carry a railroad track, a tramway, a carriage road, and foot walks. In connection with this it is proposed to extend the Anatolian Railroad from its present terminus at Haidar-Pasha to Scutari, and across the bridge to a connection with the line from Constantinople to Budapest.

The proposed bridge will be about 6,600 ft. long, but nothing is said as to the spans or the method of construction.

A Four-thousand-ton Forging Press.—The Bochum Mining & Steel Company, at Bochum, Germany, has taken to the use of hydraulic presses for forging steel ingots on a considerable scale, the largest being of 4,000-ton squeezing power. This is constructed on Fritz Baars' patent, with a central ram divided into two parts of unequal diameters, the lower half being 930 and the upper 530 mm., and arranged for three different working pressures in the proportion of 1 to 2 to 3, the effect in these cases being 1,300, 2,700, or 4,000 tons, at a maximum pressure of 600 atmospheres. The lift of the ram is 1.5 meters, and is invariable, the cross-head carrying the cylinder being fixed and not adjustable in height, like the presses made by Messrs. Tannatt, Walker & Company. The return-stroke of the ram is made by two 260-mm. plungers, which are subjected to a pressure of 50 atmospheres, and also serve as guides for the down-stroke. All the parts are cast in steel; the top cross-head, which is in two pieces, weighs 64 tons, and the cylinder of 35 tons weighed 57 tons in the rough casting. The press is manipulated by a slide-valve, moved by a lever which has only 600 mm. travel, and requires an effort of only 3 kg., being only subjected to the lower pressure of 50 atmospheres, the same pressure being used for moving the high-pressure admission and exhaust-valves by means of pistons. The path of the hand-slide is divided into three parts; the first opens the exhaust, the second the 50-atmosphere admission, and the third that for 600 atmospheres, the latter being only admitted when the ram is actually in contact with the ingot or block, and work is required to be done upon it. This makes the press very economical in work, the 4,000-ton pressure being obtained by a twin steam-pump, with cylinders 760 mm. diameter and 920 mm. stroke, cutting off at one-fifth, and making 30 revolutions per minute. The accumulator, with a compressed-air resistance, has a plunger 225 mm. diameter, and a length of stroke of 3 meters. The lower-pressure water is provided by a pair of engines 460 mm. diameter and 700 mm. stroke, pumping into a dead-weight accumulator of 450 mm. diameter and 3.5 meters lift. The engines for both high and low-pressure water, and the accumulator for the former, are provided in duplicate. The press stands in the center of a forge 33 meters in diameter, the top forming the pivot for a radial crane of 275 tons lifting-power, whose outer pillar travels on a circular railroad, the heating furnaces being arranged round about two-thirds of the circumference, in the same manner as in the large hammer forges at Bochum and Terni; there are also two pieces of apparatus for turning the work, which can be used in addition for drawing and charging the heats. These, together with the crane, are driven by the 50-atmosphere accumulator.—*Iron*.

Resistance of the Air to Falling Bodies.—Some interesting experiments on falling bodies and the resistance of the air have been recently made by MM. L. Cailletet and E. Colardeau at the Eiffel Tower, and the results have been communicated to the Paris Academy of Science. Spheres of metal were allowed to fall from the second platform of the tower, and the exact time of falling certain distances was measured to the hundredth of a second by an electric chronograph. Care was taken to eliminate any source of error, and the authors find (1) that the resistance of the air is proportional to the area of the resisting

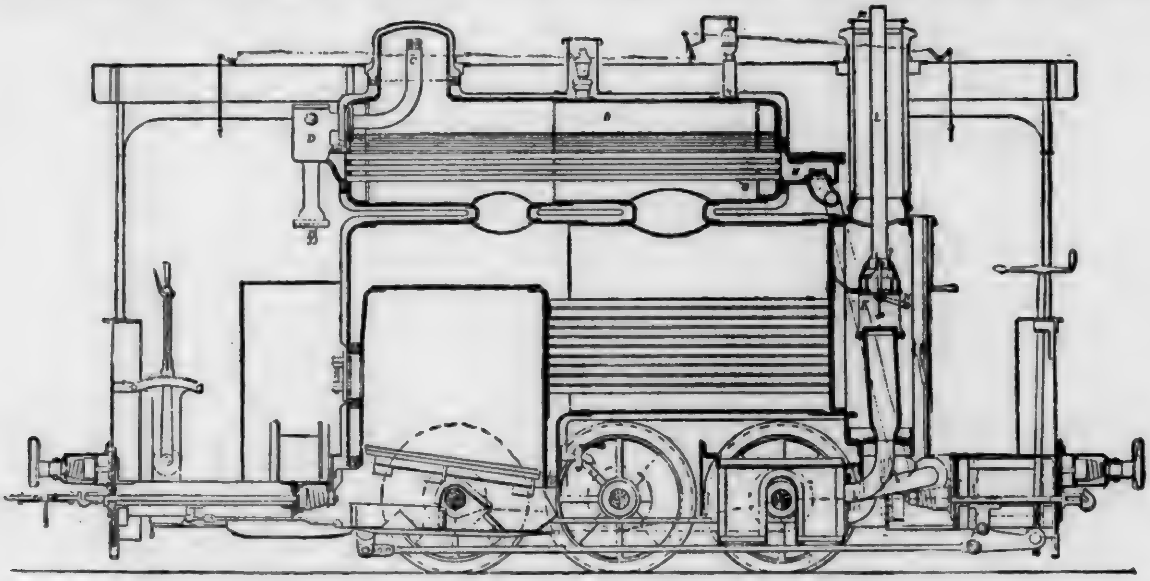
surface, but independent of its form ; (2) that it is proportional to the square of the velocity is not strictly true, as the resistance increased rather more rapidly ; (3) the amount of fall after which the velocity of the weights employed became uniform ranged from 60 to 100 meters.

A French Tramway Locomotive.—The accompanying cut shows a section of a locomotive intended for tramways or suburban work, devised by MM. Leon Franq and Mesnard. The general idea is of a locomotive with an ordinary fire-box, but provided with a boiler in which a supply of steam can be stored for use in tunnels or at points where it is desirable to suppress the exhaust and blast. The boiler, it will be seen, carries above it a cylindrical reservoir, which carries the detaining valve and reheater. This reservoir nearly doubles the quantity of hot water contained in the boiler and provides a reserve which can be drawn upon when needed.

The reducing valve *D* receives steam from the dome through the pipe *C*, reducing it to a pressure regulated by the action of the balance *E* on the lever *F*. The steam is passed into the tubular reheater *G*, where it is dried before passing to the throttle valve *H*.

When the blast is to be stopped the hood *M* is drawn over the top of the stack, and the exhaust turned through *K* into the pipe *L*, whence it escapes into the air. When the blast is to be put on again, and active combustion in the fire-box resumed, the pipe *L* is lowered and the hood *M* drawn back.

It has been proposed to apply also a system for condensing the exhaust steam, but this has not yet been carried out. The locomotive shown is a small six-wheel connected engine for suburban traffic. Several of these engines have been built for the Northern Railroad of France for use on the lines entering Paris.

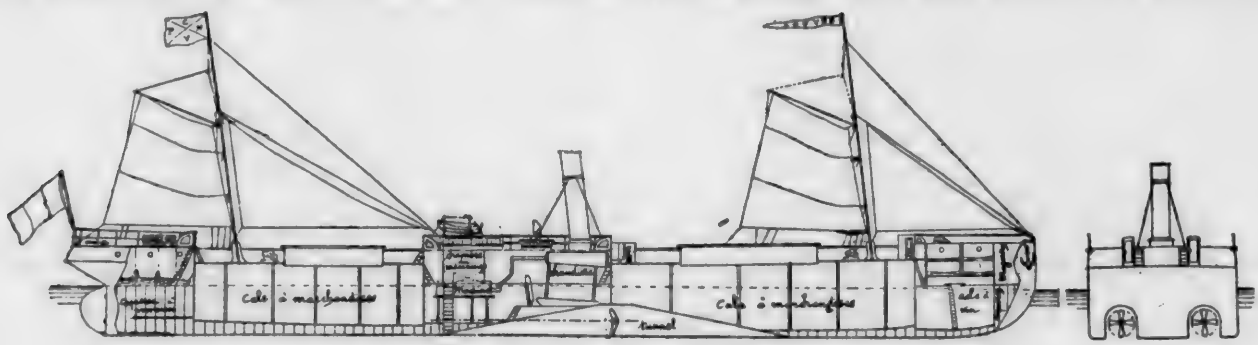


LOCOMOTIVE FOR TRAMWAY OR LOCAL SERVICE.

Rails in Tunnels.—Some observations recently made in the Altenberg Tunnel, in Germany, which is 1,230 ft. long, on rails which had been laid 11 years, showed that they were covered to a depth of 0.16 to 0.24 in. by hard scales, which could only be removed by a knife. They were composed mainly of iron sulphide, and were found principally on the web. While the weight of the rail was much reduced in this manner, its sectional area was found to have increased, owing to the flaky character of the rust. The new rails have been covered with a mixture consisting largely of tar, which is renewed every six months. The gravel ballast has also received a partial covering of broken limestone, and by these means it is hoped that the formation of rust will be retarded. In the Brandleite Tunnel, in Thuringen, it was found that rails and metal ties were destroyed by rust as fast as by the passing trains. The ties lost about 5.9 lbs. each in six years. This tunnel is nearly 10,000 ft. long.

A Center-Screw Boat.—The accompanying sketches, from *Le Yacht*, show a longitudinal section, a cross section and a plan of the *Louvre*, a vessel of novel construction, built to run between Paris and Bayonne, and so necessarily adapted to both river and coasting work. The shallow waters of the Seine limited the draft to 9.1 ft., and the vessel is accordingly made flat bottomed ; she is 171 ft. long, 27.9 ft. beam, and has a displacement of 800 tons when fully loaded.

The chief peculiarity is the adoption of M. Oriolle's plan of placing the screws at the center of the boat, in tunnels made to receive them. Their position is shown in the sketches. There are two of these screws, each 5.9 ft. in diameter and 6.5 ft. pitch. Hatchways are provided, so that any repairs to shafts or screws can be made without docking the vessel, the hatches being enclosed to a point above the water-line.



FRENCH CENTRAL-SCREW BOAT "LA SEINE."

On the voyage from Nantes, where she was built, to Paris, the *Louvre* encountered some very rough weather off Ouessant, and proved herself a good sea boat. With the engines running 60 revolutions a minute, she reached a speed of 10 knots an hour.

A Passenger Whale-back Steamer.—The accompanying diagrams show the design which accompanies the application for an English patent for a passenger steamer of the so-called

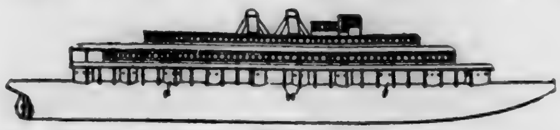


FIG 1

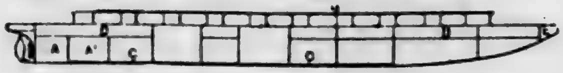
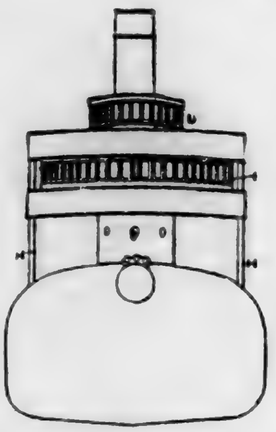


FIG 2

FIG 3



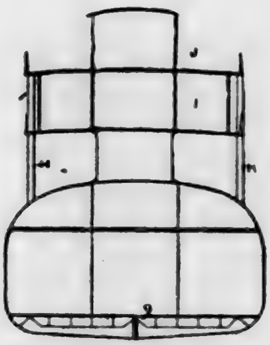


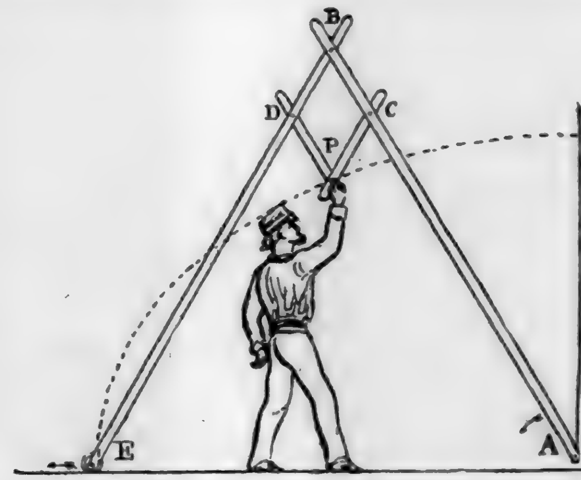
FIG. 4 FIG 5.

A WHALE-BACK PASSENGER STEAMER.

whale-back type. The general features of the proposed ship are shown in the drawings, figs. 1, 2, 3, 4 and 5, which represent a side elevation, a longitudinal vertical section, a plan of the hull, a front elevation, and a transverse section respectively. The hull has longitudinal and transverse bulkheads, and a water bottom having a metallic top, *C*, which forms a false bottom for the vessel. The bulkheads extend from the false bottom to the top of the hull, thus preventing the admission of water in case of the vessel being thrown out of its equilibrium. *D* represents a deck situate some distance below the top of the hull, which may be of any length. A A^1 are the engine and boiler rooms. The engines may be of any suitable number, but preferably three, for operating triple screws. A collision chamber, *E*, is provided at the bow, and a deck, *G*, is secured to metallic turrets *F* and additionally supported by stout braces *H* shown. These braces, which are virtually pipes, also serve for ventilation purposes. The hull is accessible from the cabin *I* by staircases through the turrets. A modification of this type of vessel is described, in which the cabin extends from a point near the stern to a point midway between the bow and stern.

How to Draw an Ellipse.—Mr. Richard Inwards writes to the *English Mechanic* as follows: "There are already so many ways known of drawing elliptic curves, that I feel some doubt as to whether I ought to trouble your readers with a new one which has occurred to me; but as the curve can be made with so simple an apparatus as four wooden rods and five wire nails, I think it may perhaps be useful to masons and scene painters who want to set out elliptic arches, or to draw circles in perspective. By this plan it is not necessary to find the foci of the ellipse, nor is any cord required.

"Let A B be a rod in length equal to half the longest diameter of the ellipse, and B E be another rod exactly similar, except that it may with advantage be fitted with a roller on its lower end. The distance C B is to be equal to half the difference between the long and short semi-diameters of the ellipse.

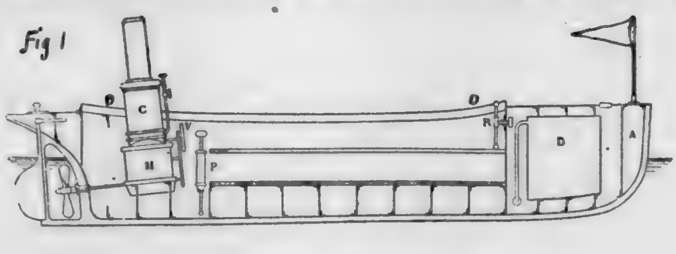


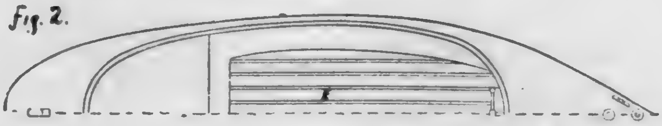
DRAWING AN ELLIPSE.

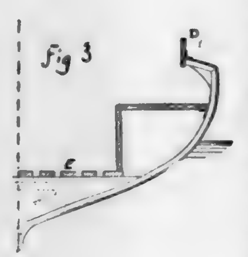
C B, C P, P D, and B D are all equal; in other words, they form a rhombus B C P D. A rotates on a nail fixed in the center of the ellipse, while E slides along A E (the floor will do very well); then the point P must describe a quarter-ellipse, whose respective dimensions are settled by the first adjustment of the lengths A B and C B. The other quarters can be got by reversing the instrument. The curve is a true elliptic one, and it may amuse some of your readers to work out the proof."

An Aluminum Boat.—Some reference has been before made to an aluminum boat built by the firm of Escher, Wyss & Company, of Zurich, Switzerland. The accompanying drawing, from *Le Yacht*, shows a second boat of this kind lately completed by that firm and now in use on the Lake of Geneva. This boat—the *Zephyr*—is 17.2 ft. long, 4.9 ft. beam, 2.2 ft. in depth and draws 1.6 ft. of water. She is driven by a petroleum engine.

In the drawing fig. 1 is a longitudinal section; fig. 2 a half plan and fig. 3 a half cross-section. In fig. 1 *A* is the anchor well; *B* the reservoir of oil; *C* the boiler or vaporizing chamber; *M* the engine; *V* the starting valve; *P* the pump; *R* the steering wheel.





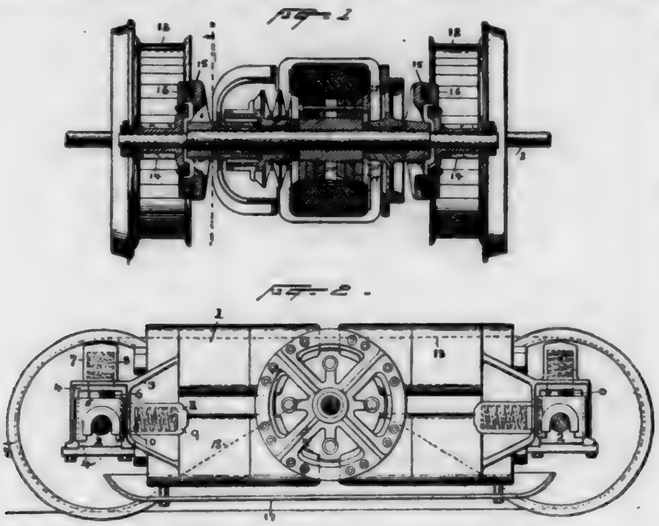


AN ALUMINUM BOAT.

The boat is entirely of aluminum except the seats, the side-rail *D D* and the floor gratings *E E*, which are of mahogany. The anchor and chain are of iron. The hull is of aluminum plates stiffened by ribs of the same metal, and the rivets joining the plates are of aluminum. The motor is rated at 2 H.P., and gives a speed of 6¼ miles an hour, which is very fair, considering the size of the boat and the fact that she is not especially designed for speed. The total weight of the boat, all ready for use, is 948 lbs., of which the aluminum in her construction forms only 287 lbs.

The Escher-Wyss works are now building a third boat—the *Mignon*—which will be 40 ft. long and will be designed for speed. She will have a cabin and two masts, and will be also entirely of aluminum except the seats, floor and cabin fittings.

The Edison Electric Locomotive.—Mr. Thomas A. Edison has lately patented a new form of electric locomotive, the main object of his device being to support the motor directly from the car-axles in such manner that the axles may be capable of moving slightly relative to the motor, as hereinafter



EDISON'S ELECTRIC LOCOMOTIVE.

described, and in such manner that power may be transferred readily from the motor to the axles.

1 is an electric motor supported between the two axles 2 2 of the car or truck. The motor is supported directly on the axles, instead of being mounted on the frame of a truck, and this support is effected by providing one or more brackets 3, having at their outer ends boxes or sockets 4, in which are movable spring-pressed blocks 5 resting on the axles. The blocks can move vertically or horizontally in their boxes. From the upper side of each block projects an extension, 6, into a holder, 7, forming a part of or secured to the box 4. Within said holder is a spring, 8, of sufficient strength to support its proportion of the weight of the motor, but capable of slight compression when the truck is subjected to sudden jars. There are preferably two of these blocks 5 at each end of the motor.

9 is a second socket or holder on the face of the box toward the motor. Within this holder is a freely movable block, 10, which is pressed against the block 5 by the spring 11. Said arrangement of the block 10 will permit the necessary vertical movement of block 5. The springs 11 should be of sufficient strength to withstand the pull of the motor communicated through a belt or otherwise to the car-axle, but should be capable of yielding slightly under any unusual or severe strain.

12 are pulleys on the car-axles.

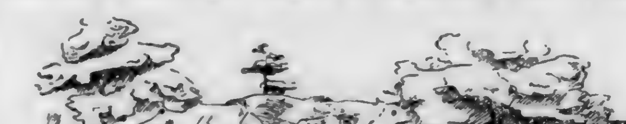
13 is a belt, preferably a chain belt. Said chain passes around a pulley on the front axle and a pulley on the rear axle, and is engaged by the cog-wheel or drum 14 on the motor-shaft. Two such chains are used, one on each side of the car. Motion is transmitted from the motor to the cog-wheel by means of a magnetic clutch consisting of one member 15 fixed to the motor-shaft, and a second member, 16, fixed to the cog-wheel and capable of turning therewith.

17 is a pan or plate under the motor to protect it from dirt. On the car-axles outside of the wheels are or may be placed the usual boxes or devices for supporting the car-body, the boxes for supporting the motor being between the wheels.

With the arrangement described when the motor is set in motion and the magnetic clutch is energized motion is conveyed to the chain belt and thence to the pulleys on the car-axles. The pull of the belts tends to draw the axles toward the motor, but owing to the strength of the springs said axles are not moved appreciably; but when for any reason an unusually severe strain or pull is given the springs, or some of them yield, allowing the block or blocks 5 to move in their boxes, thus avoiding injury to the chain or other parts. When the motor is mounted as described, it also allows the axles to move slightly independently of each other, as is desirable and necessary when the vehicle is rounding a curve. The motor ring-armature is slightly thicker at the center 18 than at the edges, so that the inner face has an inclination from the central line toward both edges, and the blocks or rings 19, which are placed around the hub on the motor-shaft, have their outer sides or peripheries 20, as well as their inner sides 21, beveled, so that said blocks or rings when drawn together by bolts 22 are securely wedged between the hub and armature-ring and firmly hold the latter in place.

A Novel Inclined Railroad.—The Bridgnorth Castle Hill Inclined Railway was opened on July 7 by the Mayor and Corporation of Bridgnorth. The ceremony of starting the first car was made the occasion of a holiday in the ancient borough, whose history as a town goes back to the time of the Danes. The picturesque scenery of this spot, the far-famed Castle Hill Walk, has not been interfered with, as Mr. G. Croydon Marks, the Engineer of the work, has concealed his railway in a cutting made some 50 ft. into the rock.

The Bridgnorth Castle Hill Inclined Railway has been constructed with the view of uniting the high and low towns of Bridgnorth, at present separated by a flight of some 200 steps and long sloping paths. The proposal emanated from Mr. Marks, of Birmingham, who had carried out similar undertakings elsewhere, and acting under his suggestions the Corporation of Bridgnorth assisted in the formation of a company for the purpose of constructing the railway. In November of last year the first piece of rock was cut, and ever since then the task of cutting through some 50 ft. of solid red sandstone has been going on. The gradient or inclination of the track is a rise of 1 ft. in a horizontal length of about 1½ ft., and the cutting has a vertical depth at one place of about 50 ft. The length of the track is 201 ft., and the vertical rise or lift is 111 ft. The system of working the inclined cars is covered by patent, embodying also the engineer's experience gathered from the working of other undertakings similar to the one on the northeast coast. The motive power is water, employed as a balance or counterweight, which is led into one car when at the top of the track, to overbalance and draw up the companion car at the bottom of the track. The two cars, each capable of carrying 18 passengers, run on independent pairs of rails, and are securely connected to each other by two steel wire cables, each of which is amply strong to do the whole work. Thus as one water-weighted car descends it causes the companion car to ascend. The steel rails are secured to sleepers bolted down to the rock, each sleeper being also held in position by being embedded into concrete blocks. Water is pumped from the bottom to the top tank by means of a pair of double-acting horizontal pumps, driven independently by a pair of the latest type "Forward" gas engines. The rope for connecting one car with the other is duplicated, both being steel wire cables of Craddock's make, each capable of sustaining a load 15 times



THE BRIDGNORTH INCLINED ROAD.

that which has to be brought on to the cars. Automatic wedge brakes come into action in the event of either, or, what is impossible, both of the ropes breaking. Brakes also come into play if too great a speed is attained, and instantly arrest the motion of each car by gripping the rails on all four sides. Cars cannot run down the incline by themselves, and if left untouched they will stop. It is only when both brakemen wish the cars to go that they can move.—*The London Engineer.*

THE RAILROAD AND
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(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, OCTOBER, 1892.

THE publication of the second paper in the series on testing material by Drs. Dudley and Pease has been postponed for a short time, to await the completion of some important investigations. The authors wish to make these papers as complete as possible, and a short delay is preferable to a too hasty publication.

THE Union for the Improvement of the Canals of the State of New York has called a convention to meet in Buffalo, October 19, to which boards of trade of the cities of the State and other similar associations are invited to send delegates. The object is to give expression to popular opinion in favor of maintaining and improving the canals, to organize a strong permanent association, and to favor the formation of local organizations for the same purpose.

WE are requested to state that the reference made by Mr. D. E. Hughes, in his paper on Transition Curves, in the July number of the JOURNAL, was to a paper read by him before the Technical Society of the Pacific Coast in April last, and not to a paper published some years ago, as assumed by Mr. Ward in his answer made in the August number. Those who have followed the discussion will recognize a material difference.

THE American locomotive has again shown that its characteristic qualities are unaffected by climate. The elaborate blue book giving an account of the investigation into the Baldwin engines, ordered by the New South Wales Railway authorities, shows that the whole body of railroad men there, though trained in the English school and accustomed to English engines, greatly preferred the American engines for their great hauling power, easy riding on the road, and flexibility in taking curves. Even the attack on the engines appears to have been mainly actuated by political motives, and did not allege that the engines were inferior to English engines, but to certain "Scotch Yankees," which are passenger Mogul engines built after American drawings by the Dubs Works in Scotland. A large number of tables are given in the blue book showing the cost of repairs, etc., but it is amusing to find that the greater part of the cost was due to collisions and derailments caused by misplaced switches, etc. Diagrams and particulars are given of the performance of a 10-wheel passenger engine, which for several miles exerted a tractive force of over 19,300 lbs., a performance which we recommend to the notice of our contemporary, the London *Engineer*, as it goes far to explain why the British colonies select American engines when there is work to be done. A note to a trial of a consolidation freight engine on a grade of 2½ per cent. with 9-degree curves states that it hauled a greater load than is usual in good practice in Great Britain on a 1 per cent. grade with far easier curvature.

THE torpedo-boat *Cushing* has had her first trials with torpedoes; they took place in Peconic Bay, at the eastern end of Long Island, and were very successful. The *Cushing* has been in commission for some time, but has had no opportunity for practice, because the torpedoes were not available. A supply of the Whitehead pattern, however, has at last been procured and can be used.

THE International Railroad Congress met in St. Petersburg, August 22, about 300 delegates being present. A number of interesting reports were ready for the Congress, to some of which reference has already been made in our columns. The meeting is referred to on another page.

THE Russian Trans-Caucasian Railroad is proving successful as a commercial as well as a military line. The receipts from general traffic last year were over 16,000,000 roubles, largely exceeding the estimates made when the road was built. The railroad is doing much to make Russian influence the ruling power in Central Asia in a commercial as well as in a political way—and in the present age the two have a very close connection.

REGULAR work has been begun on the Western Siberian Railroad. Resident engineers have been appointed for several sections, and a considerable force is at work on the grading. There is no doubt of the intention to push the work, and full preparations are being made for a supply of material as it is needed.

UP to the present time there have been very few locomotives in this country with driving-wheels over 6 ft. in diameter, and indeed 6 ft. has been an exceptional size. The largest drivers we can now recall were 7 ft. 6 in. in diameter, and were used for a time many years ago on the Camden & Amboy Railroad. Now that there is a demand for fast time, however, the large driver is to be tried in service. The New York Central & Hudson River Company has just turned out an engine with 7 ft. drivers from its West Albany shops; and the new compound engine which is under construction in the Pennsylvania shops at Altoona is also to have 7-ft. driving-wheels.

SO many towns and cities are now using electric motors on their street cars that it will seem a little strange to note that New York has just begun to operate its first electric railroad. A few cars with storage batteries were run on

the Fourth Avenue line some time ago, but the experiment was soon discontinued. The road now worked by electricity is that of the Union Company, which owns several lines of large traffic, all in the annexed district north of the Harlem River. These lines are not new, but have hitherto been worked by horse power. Overhead wires are used, the current being taken from a single power station placed in a convenient situation.

THE eastern section of the Merwede Canal, which is to give the port of Amsterdam in Holland a new outlet, was recently opened. This section is 28 miles long, and extends from Amsterdam across the Leyden Branch of the Rhine and past Utrecht to the Leck near Vreeswyck. It has a minimum depth of 10½ ft. and a breadth of 100 ft. The second section is now under construction; it will be 15½ miles long, from the Leck to the Merwede near Gorinchem. The first section has been under construction for several years, and is an important work.

AT the Iowa State Road Convention, held recently in Des Moines, some good papers on road construction and maintenance were read. A permanent organization was formed to agitate the question of road improvement, and arrangements made to bring the matter before the Legislature, with a view of securing improvements in the road law.

It is to be noted that all the speakers condemned the old system of working out road taxes; and also that many of them advocated the use of wider tires on wagon wheels.

IN Missouri also a road convention was recently held, at Chillicothe, which was largely attended. This convention adopted resolutions in favor of large road districts, with proper supervision, and the classification of roads into three divisions, according to their character and importance. State aid to the districts for macadamizing the more important roads was advocated. Here also the working out system for road taxes found no friends, and the broad tire had many advocates. In connection with the meeting there was quite a large exhibit of road-working machinery.

THE survey made by the steamers *Thetis* and *Albatross*, to determine the practicability of laying a telegraph cable between California and the Hawaiian Islands, has resulted in the discovery of a lane along the bottom of the Pacific Ocean with an average breadth of 300 miles and a length of about 2,100 miles. The crust of the earth along the belt was found to have a gently undulating surface, with here and there a sharp peak rising abruptly toward the surface of the ocean. Three lines of deep-sea soundings were run between October, 1891, and May, 1892. Two were along great circles of the earth between Monterey Bay and Honolulu and Point Concepcion and Hilo Bay, respectively, and the third was on a rhumb line between Monterey Bay and Honolulu.

The route considered as the most practicable one for the cable lies at an average depth of 2½ nautical miles along a mercator line between Monterey Bay and Honolulu—that is, nearly straight on the charts in ordinary use by navigators. This route is found to require a minimum length of cable in passing over an even bottom consisting of soil which is favorable for its protection and preservation, avoiding submarine mountains and volcanic regions where substances exercising injurious chemical action on the covering of the cable are likely to exist and where future convulsions may cause its destruction.

THE loss of the steamer *Western Reserve* has attracted much attention among shipbuilders, from the fact that it is the first serious casualty to any of the large steel steamers which are becoming so numerous on the lakes. The only survivor states positively that the ship broke in two in a sea which was not by any means as high as some that are met with, and it seems to be a grave question as to whether there was not some structural weakness. Her builders have always borne a high reputation, and they claim that in every respect she was fully equal to other boats of her class. They have given information freely as to the design of the boat and the material used in her construction.

There seems to be, in fact, no doubt that the *Western Reserve* was well and honestly built. The question raised by her loss is really as to the designs in use, and it may well be asked whether the tendency has not been to secure light draft and great carrying capacity at the expense of complete safety; and whether the shocks and strains, to which vessels of great size are subjected, have not been underestimated. These are matters which need careful and serious consideration.

THE INTERNATIONAL RAILROAD CONGRESS.

THE International Railroad Congress, the most important body of the kind in Europe, this year held its meeting in St. Petersburg, the session lasting from August 20 to the end of the month. We have before referred to the organization of this Congress, which is composed of delegates from railroad companies and from the ministries of railroads and public works of the different European countries. As with most of our own associations its powers are limited to advice and recommendations for the most part, and its decisions are not binding on members; but it has authority to settle certain questions relating to exchange of traffic and international connections.

In the intervals between the meetings of the Congress a permanent commission is in session, which has charge of the preparation of reports and other business to be submitted. This year a large number of reports were prepared and printed, some of them of much value—notably those on the wear of steel rails, on compound locomotives, and on the equipment and management of secondary or light railroads—and much business was ready for the meeting.

Full reports of the proceedings have not been received, but those at hand indicate that the discussions were not as full or extended as usual, and that a large part of the time was devoted to entertainments and to visits to and inspections of the Russian railroads. General Petroff was chosen to preside over the Congress, with M. de Laveleye as Chief Secretary, and the proceedings were conducted in the usual form, the members being divided into sections. To each section was assigned a certain class of questions, and its decisions were submitted to and discussed in general session.

The more technical questions relating to construction of road and equipment seem to have been lightly passed

over. The most extended discussion was on a traffic question—the best methods of promoting passenger business, with especial reference to the "zone tariff" system as adopted by the railroads of Austria-Hungary. The zone tariff system does not seem to have found many strong advocates, and the final decision was that no general rules can be laid down, but the passenger system in each country must be adapted to its special needs and local conditions.

The Congress will hold its next session in London, in 1895. That meeting will be the first to be held in England; France, Italy, and Belgium have been the countries heretofore visited.

ENGLISH ENGINE AND TENDER STEPS.

THE engraving herewith represents the steps on an express passenger engine, which was "converted" from the broad gauge on the Great Western (of England) Railway from the designs of Mr. William Deane, Locomotive Superintendent of that line. The readers of this JOURNAL know some of our opinions of English locomotives, or

ENGLISH LOCOMOTIVE STEPS.

rather of their performance. There are, however, some features in them which might be imitated by us here to advantage. Among these are the steps which are illustrated herewith. They are long, broad and low and easy of access. Most of the steps on American locomotives and tenders are short or narrow and high and very difficult to reach, especially when the engine is on a bank. The niggardliness of human nature sometimes manifests itself in very curious ways. It has been remarked before that a mechanic in his natural state abhors ample bearing surface. Those of us on the shady side of life can all remember when bearing surfaces of shafts were almost universally made too small, and were incessantly giving trouble on that account. One of the early locomotive builders in this country never could be induced to give sufficient margin of strength in the spring hangers of his locomotives, and consequently they were incessantly breaking. A few cents would have paid the cost of making them adequately strong, but he always resisted any proposal to increase their dimensions. Until within a few years locomotive boilers were nearly always too small, when they could have been made larger. This trait of mechanical meanness led people to make the bearings of shafts and the spring hangers and boilers of locomotives just as small as it was possible to get along with. There was everything to gain by amplitude in these parts, and nothing to lose; nevertheless, these people, who were disposed to be "near," seemed to find it impossible to be liberal even in feet and inches. Old Ross Winans was wont to tell his apprentices, "Boys, if you must make a thing strong, make it d—n strong." Nevertheless, he made his boiler braces so weak that many a poor fellow was sent to that other world, which we all hope will be a better one than this, by the breaking of the braces, which were by no means "d—n strong."

Now, in designing locomotive and tender-steps, many of their builders in this country seem to be animated by this same kind of mechanical parsimony. The steps have been made just as small as it was possible to make them and have them serve the purpose for which they are intended, which occasionally they did not do, and the lives or limbs of those who are compelled to use them were sacrificed uselessly. Mr. Deane's steps would, it is thought, be improved if the lower step on the engine and the upper one on the tender were made longer. There is everything in the way of safety to be gained by making them of ample size, and nothing to lose. We may suggest that English practice in this respect might be copied to advantage, and may paraphrase old man Winans's advice by recommending profane amplitude for not only those engine and tender steps, which are in the position shown in our engraving, but also those on the cowcatcher and other localities.

THE KRAG-JORGENSEN REPEATING RIFLE.

THE announcement that the Small-Arms Board had at last found a repeating rifle worthy to be recommended for adoption in the military service of the United States has been received with satisfaction by all who desire that this country shall keep abreast, at least in the matter of military material, with the other great powers. This satisfaction is the greater as it has been feared, from the time taken to reach a decision, that either a suitable arm could not be found, or that other influences would operate against a favorable recommendation.

Even now it is by no means certain that the end has been reached, as the recommendation of the Board has yet to be formally approved by the War Department before any steps can be taken toward the introduction of the new arm.

The generally received impression that the Ordnance Department of the Army was so wedded to the Springfield system of breech-loading small arms that no proposition for a change would secure its approval seems warranted by a perusal of the

annual reports of the Chief of that bureau during the past six or eight years. That the Springfield system of breech-loading small arms is the best, or anywhere near the best, of the many military arms in use will not be admitted by many American experts whose opinion is worth the having.

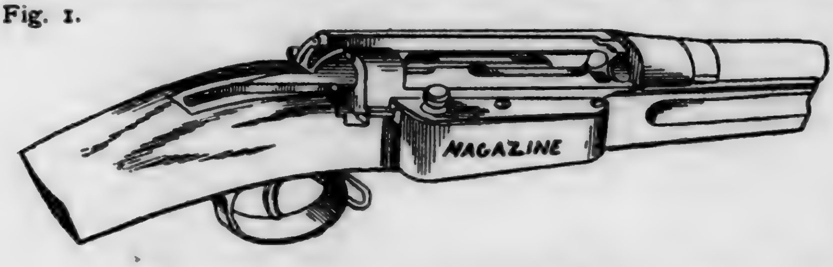
The Springfield system of breech-loaders had its birth soon after the close of the Civil War. The existing arm—the Springfield muzzle-loader—of that war was, in the first instance, converted into a breech-loader. In the conversion the barrel was shortened and the caliber reduced from .57 to .50. In the model of 1873 the caliber was further reduced to .45; and this arm, with some unimportant modifications, is the one now in use in our military service.

If we have been standing still during these twenty years, such has not been the case abroad; and it may be interesting to recall some of the changes which have taken place in the weapons of European armies in the mean time.

Following the Franco-Prussian War, wherein the value of the breech-loader was so signally established, there was a general re-armament, the Chassepot and the needle-gun were discarded, and a single-loader rifle with a caliber of about .43 was adopted by all the great military powers. The Germans had the Mauser; Austria the Mannlicher; Italy the Vetterli; Russia the Berdan, and England, discarding the Snyder, took up the Martini-Henry. It was not long, however, before the question of a repeating arm began to be agitated, and some six years ago the work of effecting this change was entered upon by all the larger European powers except Russia. Generally speaking, the existing arm was retained, or rather modified to meet the new conditions, with practically the same caliber. Before the change from a single-loader to a repeater was wholly completed in Germany, and when it was about being begun in England, the discovery by Professor Hebler that a rifle of small caliber possessed greater range and accuracy and a much flatter trajectory than the existing caliber, at once caused a halt in the work of re-armament. The advantages claimed for the small-bore arm were so great, and shown by careful experiment to be so well established, that notwithstanding the enormous sums already spent in introducing the large-calibered repeater, Germany at once set about again changing her armament, and at the present time all the German troops—of the first line at least—are supplied with the new arm. The other powers have followed her lead, or rather, perhaps, that of France, which was the first great power to adopt the small-bore repeating rifle, in the well-known Lebel. This gun is really a Kropatchek repeater, and has the modified Chassepot or Gras bolt and the spoon elevator. The German arm is the Mannlicher, with a fixed magazine holding five cartridges; the English, the Lee-Melfort, which has a detachable magazine for eight cartridges. The Lebel, it should be said, has a tubular magazine under the barrel, and contains eight cartridges. The small-calibered arm recently adopted by the Russian Government is said to be a modified pattern of the Lebel.

About the time the magazine rifle was being introduced into European armies there were issued to sixty-odd companies of our own army three different patterns of repeating arms for a sort of popular trial. Among these were the Lee and the Hotchkiss. Want of unanimity of opinion among the officers having them in charge, added to a decided preference on the part of the officials of the Ordnance Bureau for the retention of the Springfield, led to the prompt rejection of them all. The Lee, afterward adopted by Great Britain in a modified form, was believed by many experts to be the most promising arm before the

Fig. 1.



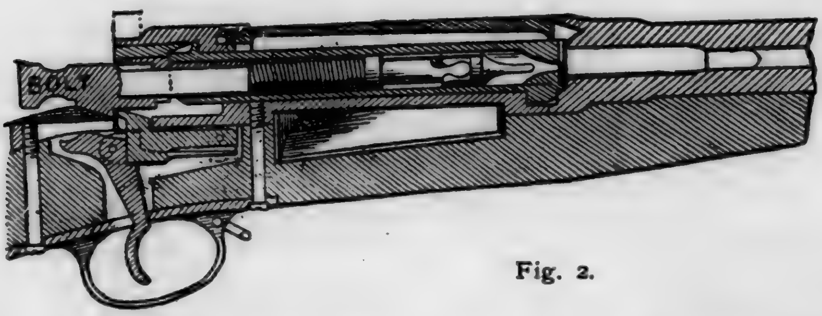


Fig. 2.

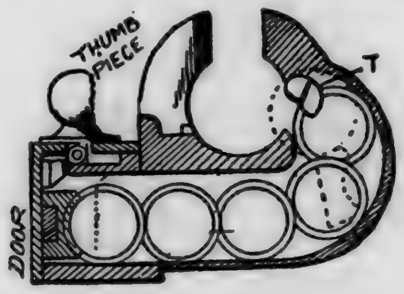


Fig. 3.

THE KRAG-JORGENSEN MAGAZINE GUN.

Board, whose final decision was in favor of the Krag-Jorgensen.

Like nearly every military arm now in use, this is a bolt gun—that is, the opening and closing of the breech is effected by a bolt moving in a direct horizontal line with the bore, carrying the firing-pin and the necessary spring mechanism for discharging the piece.

The accompanying cuts will show the principal features of the gun. In fig. 1 the breech-block is open; in fig. 2 it is closed and ready for firing, while fig. 3 shows a cross-section of the magazine, which holds five cartridges. To load the piece the bolt handle is thrown up to the vertical position. This movement starts the empty cartridge-case and unlocks the bolt. By pulling the bolt to the rear the empty shell is thrown to the right and a fresh cartridge is admitted from the magazine, unless the cut-off is on, in which case the chamber remains open for the insertion of a fresh cartridge with the fingers from the top. This last movement sets the firing-pin spring. The bolt is then returned to its original position, shoving the new cartridge into the chamber and cocking the piece.

The magazine is a fixed horizontal box, and is filled through a horizontal door on the right side, the cartridges being forced up by a spring. To use the piece as a single-loader the mouth of the magazine is closed by a gate or thumb-piece, *T*, fig. 3, after which it is manipulated like any single-loading arm.

The adoption of the new arm will place the American soldier upon an equal footing, not only with the soldiers of the great European powers, but also with those of many inferior ones already armed with repeating rifles. The particular merits claimed for the arm under consideration are simplicity of mechanism, ease of manipulation, the rapidity with which it can be changed from a single-loader to a repeater, or the reverse, and its ability to withstand the trying conditions of actual service, especially the presence of rust and dirt.

The Krag-Jorgensen under trial was made especially for trial by the American Board, and is said to be an improvement upon the weapon now in use in Denmark and Norway. The original arm has a calibre of .315, and with smokeless powder has given an initial velocity of over 2.000 ft. per second. The gun under trial had a caliber of .30, and with Wetterin powder gave velocities of something over 1,800 ft. Whether the caliber will remain that of the original arm or be made something less remains to be decided when the question of its adoption is finally settled. Its weight is 9.4 lbs., and it carries a 238-grain bullet. Its inventors are the Superintendent of the royal manufactory of arms at Kongsberg, Norway, and a battalion armorer.

It may be added that this action of the Board has still to secure the approval of the Ordnance Bureau, and that it will meet active opposition from a number of American inventors. The Krag-Jorgensen gun was patented in this country over two years ago.

NEW PUBLICATIONS.

MINERAL RESOURCES OF THE UNITED STATES: CALENDAR YEARS 1889 AND 1890. By David T. Day, Chief of Division of Statistics, United States Geological Survey. Washington; Government Printing Office.

The present volume is intended to review the mining statistics of the years 1889 and 1890, and to continue for those years the series of reports which was begun in 1886. Its appearance has been somewhat delayed by the lateness of some branches of the mining industry in making reports, and by the fact that several of the experts who aid in its preparation have been employed in work on the census.

The importance of the work is indicated by the statement that in 1890 the total value of the mineral products of the United States was estimated at $656,604,700; nearly half of this great sum—$307,334,200—being the value of metallic products, and the rest of non-metallic products, such as coal, lime, building stone, petroleum, etc. This is a greater amount than in any previous year.

Experience has enabled Professor Day to improve the arrangement of his figures and to present results in his tables in a much more satisfactory way than is done in many statistical volumes. The grouping and presentation of figures is an art not quickly learned, and which some men never do learn; but in this respect there is very little fault to be found with the present volume.

THE LAW OF INCORPORATED COMPANIES OPERATING UNDER MUNICIPAL FRANCHISES. VOLUME I. By Allen Ripley Foote. Cincinnati; Robert Clarke & Company. (Advance Sheets.)

Mr. Foote has undertaken, in preparing this book, a work of no small magnitude. His object is to give a digest of the laws of the different States governing companies holding municipal franchises, such as those for operating street railroads, telegraph and telephone lines, furnishing water, gas, and electric light, and the like. He has, as he says in his preface, "sought to elucidate principles and clearly to define strategic points in order to measure by fundamental rules the progress made by the several States in aligning legislation with the requirements of such rules." His purpose is also to bring out discussion of the principles on which legislation of this kind should be based. In other words, his object is to present a study in economic legislation, and not a mere digest of existing laws.

The first volume, which is now before us in the advance sheets, is devoted to the discussion of the law and the legal principles involved; the digests of the State laws will follow in a later volume. In preparing the latter, Mr. Foote has called in the aid of a lawyer in each State, and of Mr. Charles E. Everett as Legal Editor, and purposes making each chapter as complete as possible. The plan of this part is excellent, and the amount of labor required to carry it out may be estimated by those who have had occasion to deal with or consult the laws of one or more States. If the second volume is worked out according to promise, the book cannot fail to be of much value to a large class of people.

In his discussion of principles Mr. Foote holds to the policy of granting municipal franchises of the classes indicated to private corporations, the public authorities retaining the right of regulation, both as to the service rendered, whatever it may be, and the rates to be charged for it, the latter to be so restricted as to give no opportunity for excessive profits. To secure the best service, it is necessary that these franchises must be to a great extent monopolies; and Mr. Foote believes that in almost all cases the public will receive more from an industrial monopoly than from a political monopoly, or to put it in another way, that better service can be secured by the hope of profit than by reliance on public spirit. There are many persons who may feel disposed to differ from his views; but his conclusions are in general of a practical character and well worked out. The great difficulty in practice has been and will continue to be with the regulating power in this system.

The discussion includes, besides the statement of principles, some historical chapters showing the general course and tendency of legislation in the past, and it is very interesting reading to those who have at all studied or wish to study the subject.

SOME NOTES ON THE HOLLAND DIKES. By William Starling. *With Discussion.* Printed for the Author.

This is a reprint of a very full and careful paper read before the American Society of Civil Engineers by Mr. Starling, who has evidently studied the methods pursued in that country, in connection with his own work on the Mississippi levees. It is accompanied by maps and a number of drawings and diagrams, and gives a condensed but well-connected view of the subject. The reprint also includes the discussion of the paper, in which a number of members of the Society took part.

DUTY AND CAPACITY TESTS OF WORTHINGTON HIGH DUTY PUMPING ENGINES ON WATER WORKS AND PIPE LINE SERVICE. New York (86 Liberty Street); Henry R. Worthington.

This is a volume of 200 pages, with many illustrations, containing reports of tests of pumping engines of the class indicated by the title. Some of them have appeared before in technical journals or in the transactions of technical societies, but they are now presented for the first time in collected form. They include reports of tests made in connection with waterworks in Brooklyn, Chicago, Minneapolis, Lowell, Montreal, London (England), and other cities, and with several pipe lines, sixteen tests in all being reported by different engineers. While devoted to the tests of one type of engine, the book incidentally gives a good deal of information about pumping machinery and the different conditions under which it is called upon to work.

REPORT OF THE PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, HELD AT SARATOGA, N. Y., JUNE 20, 21 and 22, 1892. Edited by Angus Sinclair, Secretary. New York; published by the Association.

Secretary Sinclair has brought out the volume containing this year's proceedings of the Master Mechanics' Association with his usual promptness, notwithstanding the fact that it contains an unusual amount of matter, and is, we believe, the bulkiest report ever issued by the Association. This is due chiefly to the unusual length of some of the committee reports and the number of tables and illustrations accompanying them. The

most notable of these is the report on Compound Locomotives, on account both of the interest attaching to the subject and also of the amount of information given in the report itself. There are other reports of interest—those on Locomotive Tests and on Tests of Steel and Iron might be mentioned—and some of the discussions are sharp, pointed, and give considerable information. The Master Mechanics' Association is evidently fully alive and quite ready to keep up with the questions of the day as they arise and call for answers.

THE STATISTICAL YEAR-BOOK OF CANADA: 1891. By Sydney C. D. Roper, Assistant Statistician. Ottawa, Canada; the Department of Agriculture.

This is the seventh yearly volume of a publication which, while necessarily somewhat dry and unattractive to the general reader, contains a great body of information which will be valuable to all who have trade relations with the Dominion, or who are interested in its growth and progress. Like the previous volumes, it shows signs of careful preparation, and has a generally reliable appearance and convenient arrangement which do credit to the compiler.

THE COMPASS: VOLUME I, 1891–92. *A Monthly Journal for Engineers, Surveyors, Architects, Draftsmen and Students.* Edited by William Cox. New York; the Keuffel & Esser Company, No. 127 Fulton Street.

Reference has been made from time to time in our columns to the monthly numbers of the *Compass*. We have here the twelve numbers of the first volume bound in a neat book of 192 pages. Its object has been to give information concerning the making of mathematical and surveying instruments and the best methods of using them; new methods of procedure and other topics of the kind.

The promise of the first number has been well kept, and this volume contains much matter that is valuable and worth preservation. Among the contents which deserve special mention are the papers on Series of Numbers and their Practical Application, written by Mr. Cox, which contain much matter set out in a new light, and some ingenious applications of principles. The Gradienter Tables, on pages 156, 172 and 180, are complete, and will be appreciated by many engineers.

The *Compass* will be found convenient by those who want to be posted on the latest improvements in instruments of precision, and it also contains other matters of interest and value.

REPORT OF THE SEVENTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS, HELD IN CHICAGO, JANUARY 27–29, 1892. Springfield, Ill.; published by the Society; S. A. Bullard, Secretary.

This number gives a full report of the meeting of the Illinois Society for the current year; containing several papers of value by members, and reports of some good discussions on topics suggested at the meeting. The Road Question; Brick Pavements; Draniage, and other questions of present interest claimed and received full attention at the meeting, and the results are here given.

PRACTICAL CARRIAGE BUILDING: VOLUME II. Compiled by M. T. Richardson. New York; the M. T. Richardson Company. Price, $1.

This is a collection of articles on the subject which have been published from time to time in the *Blacksmith and Wheelwright*, and contains many practical notes which will be useful to carriage builders. Beginning with information regarding axles, it considers in detail the plumbing of spokes, gather of wheels, making yokes and whiffletrees, laying off a fore carriage, special tools, making ovals, blocking corners, making and laying off of patterns, and drawing of tools. Complete instructions regarding the laying off and framing of carriage bodies, construction of carriage parts and wheels, light and heavy sleighs are given. The book is profusely illustrated, and is uniform in size and style with Volume I, which appeared some time ago.

PROCEEDINGS OF THE FOURTH ANNUAL CONVENTION OF THE IOWA SOCIETY OF ENGINEERS AND SURVEYORS. Glenwood, Ia.; published for the Society, Seth Dean, Secretary.

Besides the reports of the officers and the proceedings of the Society this volume contains a number of papers by members on various topics connected with the profession. It shows that the Iowa Society is not lacking in activity and is, in proportion to its membership, doing fully as much good work as other associations of the kind.

IMPERIAL UNIVERSITY OF JAPAN (TEIKOKU DAIGAKU). THE CALENDAR FOR THE YEAR XXIV–XXV MEIJI (1891–92). Tokyo, Japan; published by the University.

This catalogue, covering the current scholastic year, shows the University of Japan to be in a flourishing condition. It includes six colleges—Law, Medicine, Engineering, Literature, Science and Agriculture—each with its own faculty. The roll shows a large number of professors and instructors of various grades, most of whom are graduates of the University; the students number in all 1,346, of whom 132 are in the College of Engineering. The number of graduates on the rolls is 1 582 now living, besides 91 who have died, making a total of 1,673 who have taken degrees.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. VOLUME XVII, 1891. Published by the Royal Engineers' Institute; Chatham, England.

The present volume is devoted entirely to the subject of Sanitary Engineering, and although written presumably for the benefit of the officers of the Royal Engineers, its scope is not restricted to the question as applied to the sanitation of military barracks, etc., but enters chiefly into that part of the subject pertaining to the disposal of sewage, surface water collection, subsoil drainage, house drains and the use of disinfectants.

The problem of how best to dispose of sewage, garbage and refuse is, with the rapid growth of great cities, becoming every year of increasing importance, and one for which no thoroughly practical and satisfactory solution has as yet been reached. In the book before us the various systems of sewerage, as employed and proposed in Great Britain, are discussed, while the questions of construction and materials, and the special appliances for use in buildings are treated exhaustively, and fully illustrated by numerous cuts and fifty-odd more or less elaborate plates. So complete is this part of the work that it might well serve as a text-book upon this subject for engineering students.

The primitive and often haphazard methods employed for the disposal of garbage and sewage by very many American cities of even considerable size explains the frequent outbreaks of typhoid fever and other zymotic diseases. The great wonder is that the mortality arising from shortcomings in this direction is no greater than it is.

A work so thoroughly practical and dealing with a question of such vital importance ought not to be restricted in its readers to the professional engineer.

JOHNSON'S TABLES: STADIA AND EARTHWORK TABLES. Reprinted from *Theory and Practice of Surveying*. By Professor J. B. Johnson. John Wiley & Sons, New York.

The purpose of this volume is perhaps best explained by quoting the Author's explanatory note, as follows:

The great use made by engineers of three of the following

tables—viz., the Four-place Logarithmic Table, the Stadia Table, and the table giving Prismoidal Volumes, has necessitated the building of these in more convenient form than that in which they first appeared in the *Theory and Practice of Surveying*. Since the cost is not materially increased by additional pages, the remaining tables are also included, as well as the entire chapter on the Measurement of Volumes.

The Stadia Tables were computed by Mr. Arthur Winslow, State Geologist of Missouri, and first published by the Pennsylvania Geological Survey. The four-place logarithm tables were originally taken from Lee's *Tables and Formulæ*, a publication of the United States Engineer Corps. The table giving Volumes by the Prismoidal Formula was computed by the Author. It is the only table, he believes, giving volumes by the prismoidal formula at one operation. It may also be used for Mean End-areas. Tables IV and VIII are also original in their arrangement.

In addition to the tables the book contains a chapter on the Measurement of Volumes and the necessary explanations of the tables. In its present form it will be found a very convenient reference book and assistant by the engineer.

CRUISES OF S. M. SHIPS "NAUTILUS" AND "AURORA" OF THE EAST-ASIATIC SQUADRON, 1884–88. By Captain Jerolim Freiherrn von Benko. Published by Carl Gerold's Sohn, Vienna.

This is one of the volumes which are issued from time to time under the auspices of the Austrian naval authorities. They give accounts of the cruises of ships, and are not simply records of travel, but are intended to convey sailing directions for the various ports visited, accounts of currents, lights and other information useful for mariners, and also such notes on the commerce of the various countries as the officers may be able to collect, and which may be useful to merchants at home.

The present volume describes cruises made by the *Nautilus* and the *Aurora* in Eastern waters, visiting many ports in India, China, Japan, and the islands of the Indian Ocean. It contains much valuable information and also some entertaining notes of travel. The statistical part, of course, will be read only by those directly interested, but there is much in the book that others might read with profit. It is a very creditable specimen of the work done by the Austrian Navy.

The book is illustrated by three large maps showing the cruises of the two ships in detail.

TRADE CATALOGUES.

The Lahman-Kirkwood Patent Fuel-saving, Shaking and Dumping Grate-bar. W. H. Lahman, No. 154 *Lake Street, Chicago.*

This is an illustrated description of a grate-bar adapted for all kinds of coal, from which, it is claimed, very good results have been obtained in service.

Train Signaling System. The Mason Air Brake & Signal Company, Chicago.

This is an account of the system of train signaling by compressed air which is now being introduced by the Mason Company. It is accompanied by drawings and diagrams showing the general construction and details of the apparatus.

Dixon's Perfected Graphite for Lubricating. The Joseph Dixon Crucible Company, Jersey City, N. J.

This is a pamphlet showing the advantages of graphite as a lubricant and the variety of uses to which it can be put, and it gives some facts which are worth the attention of those who have charge of or own machinery. It shows also the necessity of using pure graphite properly prepared.

Emery and Corundum Wheels, Emery Wheel Machinery, Flint and Sapphire Papers. The Springfield Emery Wheel Company, Bridgeport, Conn.

This catalogue contains lists and illustrated descriptions of a great variety of grinding, polishing, and surfacing machines made by the company mentioned. Its size is in itself a proof of the extent to which emery and similar wheels are now used in machine work, and the importance which their manufacture has attained. The catalogue will furnish some useful hints to manufacturers.

The Universal Cutter and Reamer Grinder as Made by the Brown & Sharpe Manufacturing Company, Providence, R. I. Illustrated.

This pamphlet gives a description of the universal cutter and reamer grinder made by the Brown & Sharpe Company, with a number of the applications of the tool to various purposes. The descriptions are generally clear and are very fully illustrated, and give a complete idea of the uses to which the machine can be put. A careful reading will certainly give the machinist or foreman some information, and possibly some new ideas. The pamphlet will be sent to any applicant by the company named.

Air Compressors: Duplex and Single, Actuated by Steam, Belt, Gearing or Water Power. Catalogue No. 7. The Clayton Air Compressor Works, New York and Brooklyn.

This catalogue contains descriptions and illustrations of a number of air compressors of different patterns made by the Clayton Works and adapted to various pressures and to different kinds of work. The use of air compressors is increasing in many directions, and their manufacture is an interesting branch of mechanics, in which no small degree of skill and experience is required. An inspection of this catalogue is required to show the great variety of uses now found for this class of machinery.

Catalogues and Price-lists of the Brown & Sharpe Manufacturing Company: New Edition, 1892. *Providence, R. I.*

The extent to which the business of this firm has grown is shown by the size of its catalogue. In 1875 a book of 66 pages was sufficient; in 1879 this had grown to 100; in 1889 to 205; last year it had 228, and the present edition has 248 pages. This growth has been by the addition of new machines and not by elaboration of the matter. How this is done is shown by the list of additions made this year, which include the No. 8 plain milling machine; vertical spindle milling attachment for No. 8 plain milling machine; 13-in. engine lathe; No. 2 automatic screw machine; new arbors for milling machines; new collets for milling machines; new sizes of milling cutters; new sizes of end mills; special miter gear patterns; bevel gear cutters; 10-in. and 12-in. index centers; standard caliper gauges for sizes larger than 3 in.; rubber gauge; new special gear patterns; new sizes of gear cutters; concave and convex cutters with formed teeth; standard angle irons, and others of less importance.

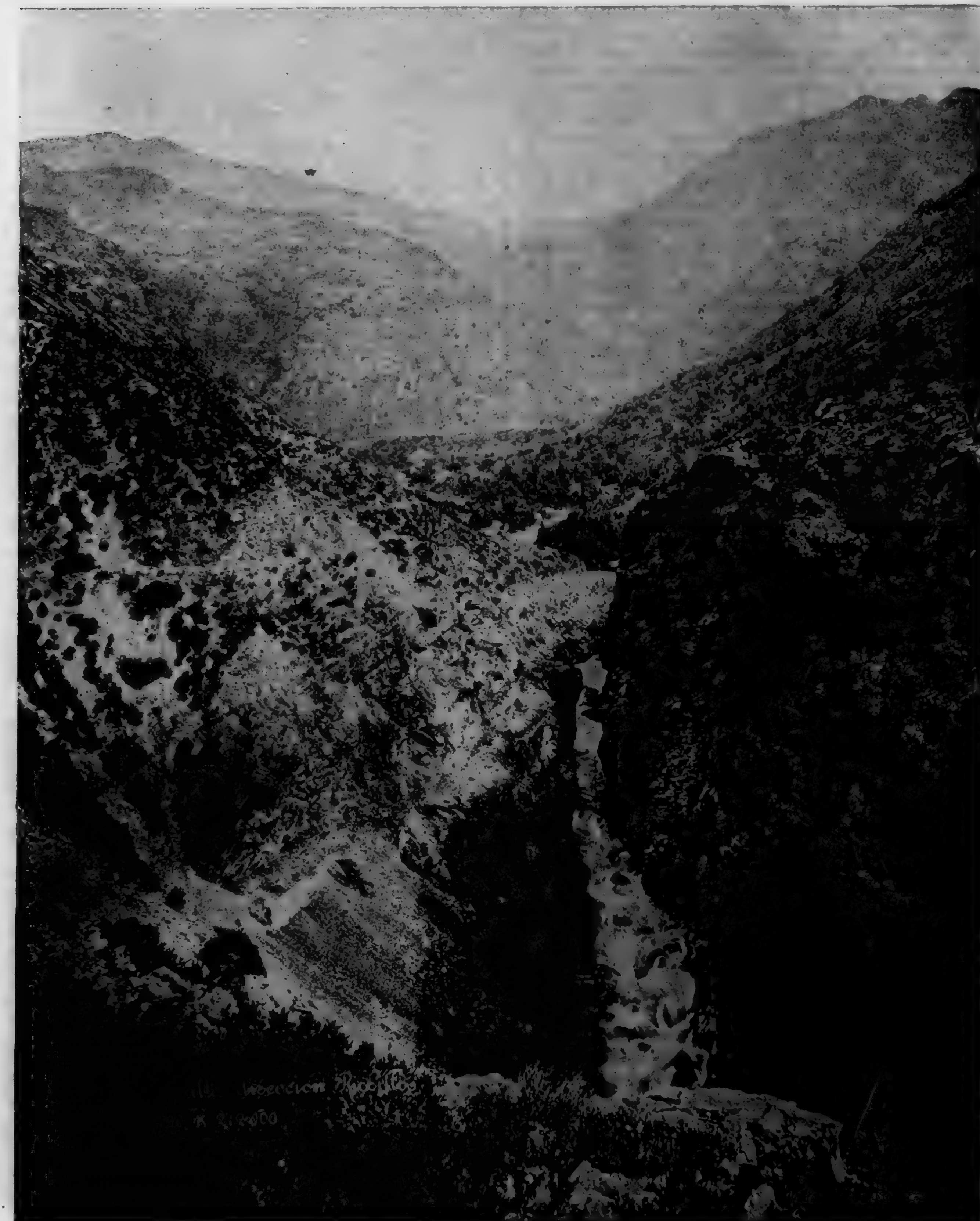
The *Egan Company*, of Cincinnati, has issued one of the most complete catalogues of wood-working machinery ever published. It contains over 500 pages of illustrations and descriptions of a great variety of tools. It is very handsomely printed and the engravings are good.

Price List of Picks, Mattocks, Etc., made by the Columbus Manufacturing Company, Columbus, O.

CURRENT READING.

AMONG the books in press by Houghton, Mifflin & Company is a new and enlarged edition of Mr. Rowland Cox's MANUAL OF TRADE-MARK CASES, an exceedingly useful work for manufacturers and many others.

The MARINE RECORD, of Cleveland, O., has recently enlarged its size and made many improvements in its pages. Our co-



THE TRANSANDINE RAILROAD.—"EL SALTO DEL SOLDATO."

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On the Argentine side of the mountains construction trains are running to Punta de las Vacas, 87 miles from Mendoza. On the Chilean side the track is laid from the starting point at Santa Rosa de os Andes to El Salto del Soldato, a distance of 23 miles. This leaves 23 miles on the Argentine side and 17 miles on the Chilean side still to be completed, but on both these sections much work has already been done. Of the 40 miles unfinished, nearly one-fourth is in tunnel, which gives a fair idea of the great difficulties which the engineers have had to encounter.

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SOME CURRENT NOTES.

THE prizes which were offered by the German Railroad Union in 1890 have been awarded as follows: The first prize of 7,500 marks to Herr Von Borries for improvements in compound locomotives; the two prizes of 3,000 marks each, one to George Westinghouse, Jr., for improvements in atmospheric brake, and one to Paul Langbein for an apparatus for transferring cars between standard and narrow-gauge tracks. The six prizes of 1,500 marks each were given to M. Wedler for an apparatus for preventing injury to men working at lathes; to M. Vaolmar for improvements in movable axles; to G. Hautzel for a paper on Track Ballast in its Statical Relations; to Professor Launhardt for a treatise on the Theory of Location; to Railroad Inspector Kolle for a treatise on Apparatus for Protecting Switches and Signals, and to Ludwig Kohlfürst for his book on the Development of Electrical Appliances for Railroads.

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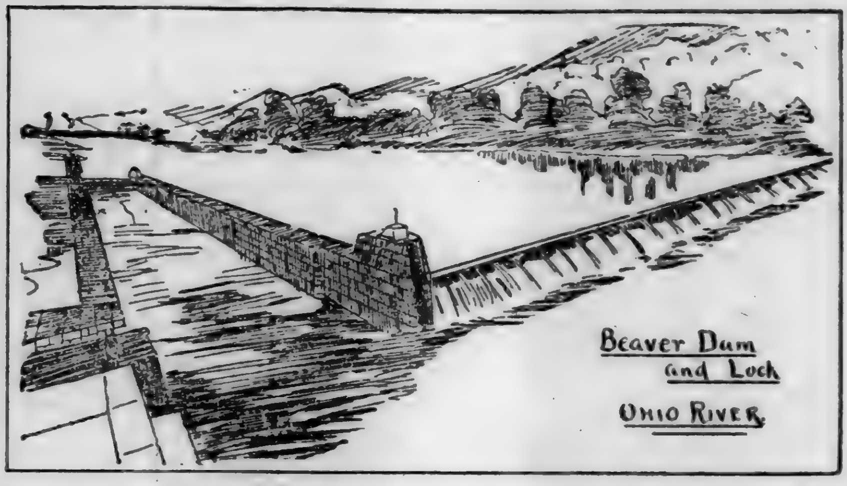
A special feature is the lock, which has to be adapted to the commerce of the river, and is therefore made very large. The one belonging to the Beaver Dam will be 600 ft. long and 110 ft. wide in the clear, giving an area of 66,000 sq. ft. The lock will permit a towboat, 14 barges and two flats to pass through at the same time. On account of the great size of the lock, several special features will appear. For instance, the miter-gates, ordinarily used for locks, would be too unwieldy for use there, consequently the one adopted is like a Howe truss-bridge laid on its side in such a position as to place the bottom down stream and the top up stream.

The dimensions of the gate will be 118 ft. in length, 13 ft. 6 in. in breadth, and 15 ft. in height. In its passage from the upper to the lower pool the water goes through the upper gate recess; thence it passes by means of seven openings, 4 ft. 6 in. in diameter, into the filling culvert, 9 ft. wide by 13 ft. high. It lies behind the entire length of the lower wall of the upper recess, and then turning sharp to the right it follows the land wall for a distance of 250 ft. In the land wall are built 10 openings 3 ft. × 3 ft. 6 in., through which the water passes from the filling culvert into the lock chamber. From here it passes through the lower recess by means of seven openings similar in size and location to those in the upper recess, into the emptying culvert, whence it flows into the lower pool. The land wall, including the walls of the gate recess, will have a development of 1,170 ft., and will contain about 6,000 yds. of masonry. The river wall will be



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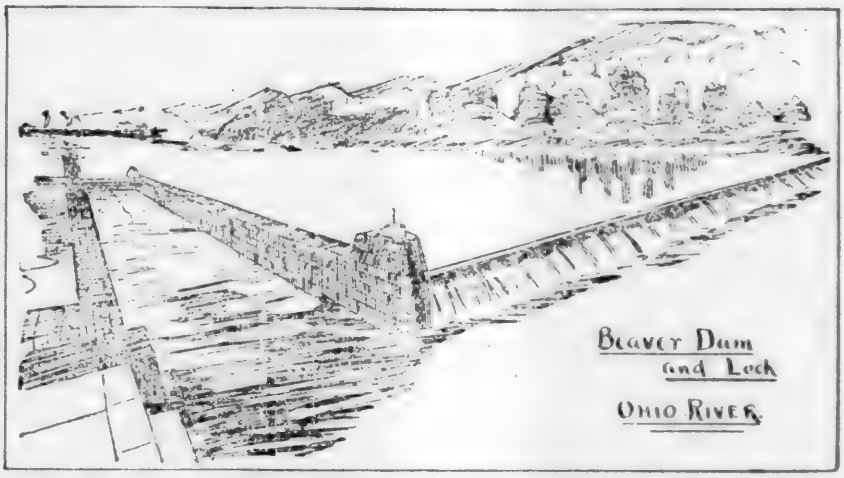

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power and provide a supply of water in the dry season, a canal some 15 miles long will be built to connect Lake Pantano with the Guadarrama, the lake being thus utilized as a storage reservoir.

The plan also includes the use of the water after passing the dam and water-power to supply the city of Madrid and irrigate the country surrounding it. This will be done by clearing out and repairing the ancient Canal del Gasco and extending it to a point near Madrid, where suitable distributing reservoirs can be built. The old canal covers more than half the distance, including the mountain region where construction is most difficult.

The city of Madrid now has a very insufficient water supply, and the new project, it is expected, will much improve its health and convenience. The distance over which the electric power is to be transmitted is much less than that from Lauffen to Frankfürt, where this method proved successful.

NEW TYPES OF THE BELPAIRE BOILER.

In a note read recently before the French Society of Civil Engineers at Paris, M. Lencauchez described some new types of locomotives recently built for the Belgian State Railroads. The object in all of these was to secure a greater production of steam, and thus enable the engines to meet the requirements of increased speed and increased weight of trains. On the Belgian State Railroads the Belpaire boiler is the accepted type, and the boilers of these new engines have been designed by M. Belpaire with a view to securing larger grate area and heating surface.

Fig. 1 is a locomotive built to run express trains on the Luxembourg line, where there are grades of 1.6 per cent. of considerable length. On these lines the express trains have an average weight of 110 tons, and are required to run at an average speed of 37 miles an hour, 46 miles being the maximum allowed. The sketch shows a side elevation and a rear view, while below a cross-section and longitudinal section of the inside fire-box are given. From the latter it will be seen that the fire-box is carried out to the full width allowable, and that it is entirely above the frames and is very shallow in proportion to its width.

This engine has three pairs of coupled wheels 67 in. in diameter and one pair of leading wheels, the journals of the latter running in radial axle-boxes. The cylinders are 19.7 in. in diameter and 23.6 in. stroke. The boiler is 55 in. in diameter, and has 236 tubes 1.97 in. in diameter and 13 ft. 3 in. long. The fire-box is nearly 9 ft. in width, and the grate area is 61.79 sq. ft. The fire-box heating surface is 161.4 sq ft., and the total heating surface is 1,573.9 sq. ft. The usual working pressure is 150 lbs. The boiler is of steel and the fire-box of copper. The cylinders are inside and are not placed in the smoke-box, but back of the axle of the bearing wheels. The smoke-stack is square in section and tapers from the base to the top.

The total weight of this engine in working order is 117,000 lbs., of which 90,100 lbs. are carried on the coupled wheels. The valve gear is of the Walschaert type.

In some experiments made with one of these engines, using a soft bituminous coal, from 53 lbs. to 57 lbs. were burned per square foot of grate per hour. Their performance on the road has been satisfactory.

Fig. 2. shows a type of engine built to run the heavy express trains on the more level lines, where there are no grades exceeding 0.5 per cent. The trains usually weigh about 150 tons, and the maximum speed is 55 miles an hour. This engine has four coupled wheels 82.7 in. in diameter, with a pair of bearing wheels forward and another under the fire-box. As in fig. 1 the cylinders are inside and the general arrangement is very similar. The cylinders are the same size, 19.7 in. in diameter and 23.6 in. stroke. The main difference is in the boiler and fire-box. The form of the latter is shown in the rear view, and in the smaller views given underneath.

The boiler is 51.2 in. in diameter and has 242 tubes 1.77 in. in diameter and 12 ft. 7½ in. long. The grate area is 50.7 sq. ft. ; the fire-box heating surface is 134.6 sq. ft., and the total heating surface 1,342 sq. ft. The usual pressure carried is 150 lbs. The total weight of the engine ready for service is 108,400 lbs., of which 57,750 lbs. are carried on the coupled wheels.

Fig. 3 shows a freight engine designed for the heavy grades of the Luxembourg line, mentioned above. The cylinders are the same size as those of the other engines shown, 19.7 in. in diameter and 23.6 in. stroke. There are three pairs of wheels, all coupled, and 47.2 in. in diameter. The weight of the engine in service is 95,200 lbs., all of which is on the drivers. The work which this engine is called upon to do is to haul trains of 230 tons' weight (exclusive of engine and tender) over grades of 1.6 per cent. at an average speed of 18⅓ miles an hour. In service and running a trial train of 230 tons, the boiler has vaporized 24,990 lbs. of water per hour, or 19.2 lbs. of water per square foot of heating surface per hour.

The boiler is very similar in form to that of the engine shown in fig. 2. It is somewhat larger, being 55.1 in. in diameter, with 251 tubes 1.77 in. in diameter and 11 ft. 6 in. long. The grate area is 55.4 sq. ft. ; the fire-box heating surface is 122 sq. ft., and the total heating surface, 1,299 sq. ft. The usual working pressure is 150 lbs.

It will be noted that in all these engines M. Belpaire has seen the necessity of increasing the grate area, and has done it by making a wide, shallow fire-box, and raising the boiler so as to bring the fire-box entirely above the wheels. He has approached in some respects the Wootten boiler, but to preserve his own characteristic type of boiler he has adopted plans which make a somewhat difficult form to make and stay properly, especially in the plan shown in the first engine.

SOME RAILROAD HISTORY.

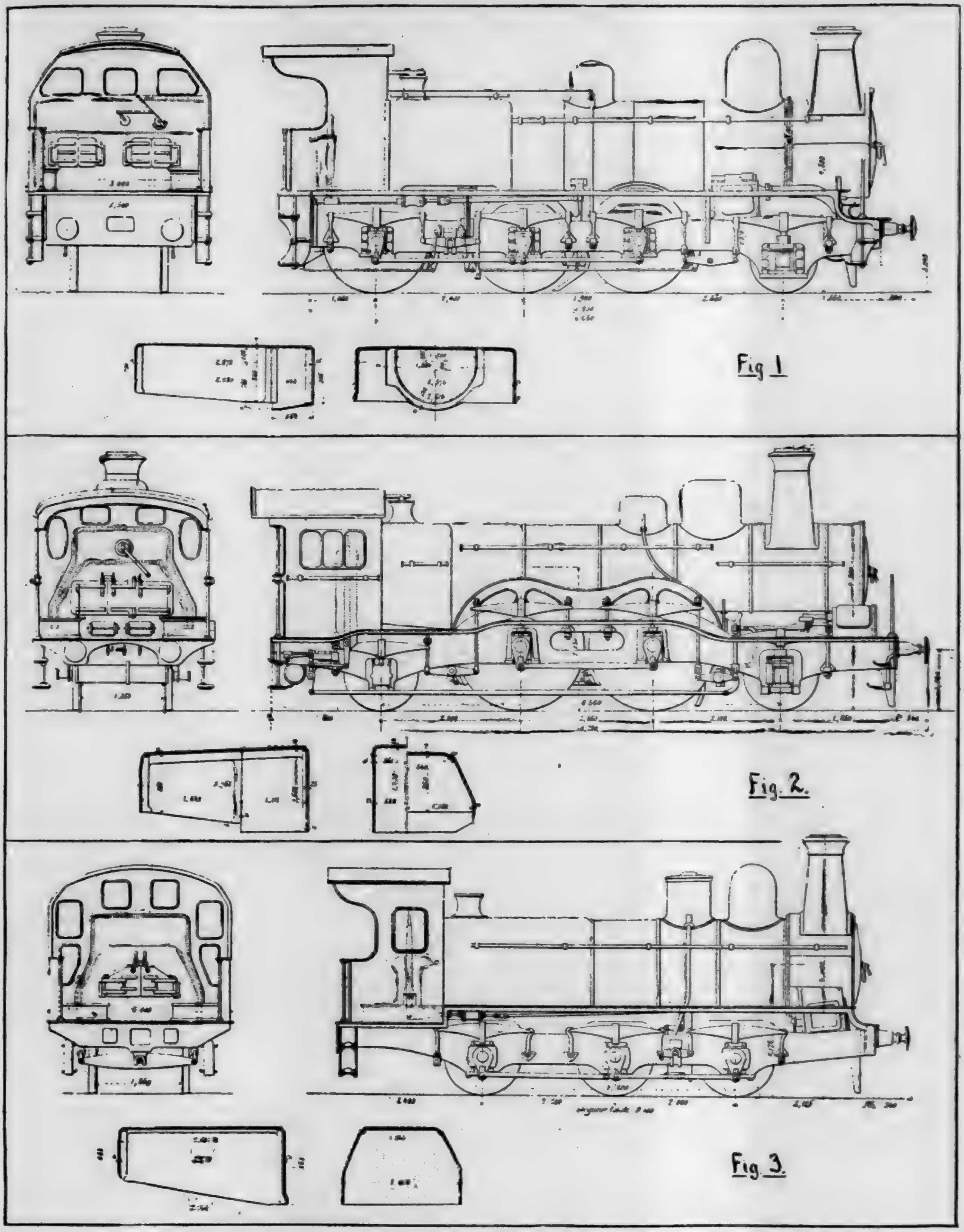
An interesting document now before us is a copy of the report of the South Carolina Railroad Company for the six, months ending October 1, 1834. The road was not then completed, but a portion of it had been opened and in operation for about four years, and a year or two later the main line from Charleston to Augusta was finished. The contrast between the railroad of nearly sixty years ago and that of to-day is so well brought out that it seems as if some extracts from the pamphlet—which is, very possibly, the only copy still in existence—may be of interest to our readers.

The pamphlet includes the reports of Mr. John Ravenel, the President of the Company, and of Mr. Horatio Allen, the Engineer, both men well known in their day, and both now dead. It gives also in two or three pages of tables the financial statements of the Treasurer and Auditor ; these present nothing of especial note except that we find several "negroes" included among the assets of the company, and credited on the balance sheet at their appraised value.

President Ravenel's report speaks of the condition of the road as follows :

Since the meeting in May last two improvements of value have been completed, to wit, a stationary engine, by which the labor and expense of our workshops are greatly reduced, and a depository for the reception of up freight ; the arrangement of which facilitates loading, and enables us to forward freight in the order as to time in which it is received. A cotton depository, being under contract, will soon be erected near that just described, when the buildings at Line Street will be appropriated exclusively to the construction, repairs, and protection of engines, cars, etc.

Agreeably with a recommendation approved at the last general meeting, the 1,185 shares, then held by the Company, have been sold and the proceeds applied to the purposes of the Company. The two locomotives then reported as looked for shortly, from Mr. E. Bury, of Liverpool,



NEW TYPES OF LOCOMOTIVES, BELGIAN STATE RAILROADS.

arrived on September 9, were immediately placed upon the road, and, we are happy to say, have performed with great profit to the Company and credit to the builder. Four others ordered from England, on March 3 last, are expected soon to arrive, when we shall have ample power for present purposes. In anticipation of a great increase of business, an order for six engines was forwarded on the 4th inst. to William C. Molyneaux, Esq., of Liverpool, to be executed with dispatch, and arrangements are in progress here to convert the boilers and such other parts as are suitable and good of the *Charleston, Barnwell* and *South Carolina* into engines upon 4 or 6 wheels. The Board, after much and minute investigation, being of opinion that six durable engines of considerable power can be constructed out of the materials which would otherwise be useless and lost.

Although not so stated directly in the report, it would appear from other portions of it that the three engines which were thus to be rebuilt were the double-truck en-

gines built by Mr. Allen, drawings of which were published in the JOURNAL for March, 1890. From the report and the inventory of the property of the road which accompanies it, it appears that the Company then owned 15 locomotives. The list is as follows, including the original cost and the appraised value at the date of the report:

ENGINE.	Builder.	Cost.	Appraised Value.	Remarks.
Edgefield	R. Stephenson & Co., Newcastle	$5,625	$5,000	In use.
Augusta	E. Bury, Liverpool	5,300	5,300	" "
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Columbia	Fenton & Co., Leeds	5,915	4,500	" "
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Horry	E. L. Miller, New York	5,000	3,000	" "
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In the list of cars owned we find 23 passenger cars, of which 13 are valued at $450 each, and 10 at $400 each. There were 149 freight cars, of which 99 were "high covered cars, with springs," and were rated at $225 each; 27 "low cars, with springs," worth $200 each, and 23 "low cars, without springs," at $150 each. Three baggage cars were valued at $250 each and three at $180 each, while 13 "embanking cars" were charged at $1,656 for the lot. In addition to these, two passenger, three baggage, and 72 freight cars are reported as unfinished.

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1. That 12 apprentices be taken, natives of Charleston, or so long residents therein as to be inured to the climate.

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4. That the Company provide the apprentices with board, and lodging, and washing, or a stipulated sum, payable at the end of the year, on good behavior, but not with clothes.

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The report of Mr. Horatio Allen, after some brief statements as to contracts, goes on to give some information as to the condition of the road and the experience in operating. It should be noted here that the superstructure, as originally built, consisted of longitudinal wooden sleepers resting on piles driven in the ground, making a sort of continuous pile bridge. In some places sand or earth was filled in to the top of the piles. The rail was simply flat bar iron spiked to the wooden sleeper. Mr. Allen says:

There are now 65 miles of road, "surface construction," of which 27 miles are filled up level with the rails.

A careful examination of the piles and other wood-work has been directed and made within the last two months; which has resulted in the satisfactory reports that apparently almost the entire road exhibits few signs of decay, and that the few exceptions are where the timber was originally inferior, or where the road runs within the first six miles through the dry sand ridges. To all such cases close attention is paid, and in filling up the road, a particular attention is had to the relative state of the various parts. It is especially satisfactory to know that where the road is elevated in consequence of its passing over low grounds, the piles remain unimpaired, and possess to all appearances the same strength and security that have so long stood the test of long trains of cars and engines heavier than it was originally intended to use.

It is also a highly gratifying fact that of the accidents that have occurred on the road, not one, to this day, can be attributed to a failure or defect in the road. It may not be uninteresting to have stated what have been the sources of those accidents that have occurred.

They have been found in three causes. 1. From the improper position in which the gates and crossing rails of the turnsout were in when the engines or cars have attempted to enter or leave the passing places. Such are therefore attributed to the neglect or mismanagement of the attendants at the turnsout. Our efforts and arrangements to remove this source of accidents have been nearly successful, and it is believed they will be hereafter of rare occurrence.

Another source of accident has been in the running one engine against another, and in some instances against animals that cross the road before the engine.

It is, however, principally from the breakage of axles that most of the accidents have originated. It is probable that the use of high cars and elevated loads of cotton have occasioned the breaking of the same sized axles that have previously, with the low cars, been found adequately strong. Measures were taken some time since to guard against such breakage by reducing the loads carried by the present cars and having all the new axles made of larger dimensions.

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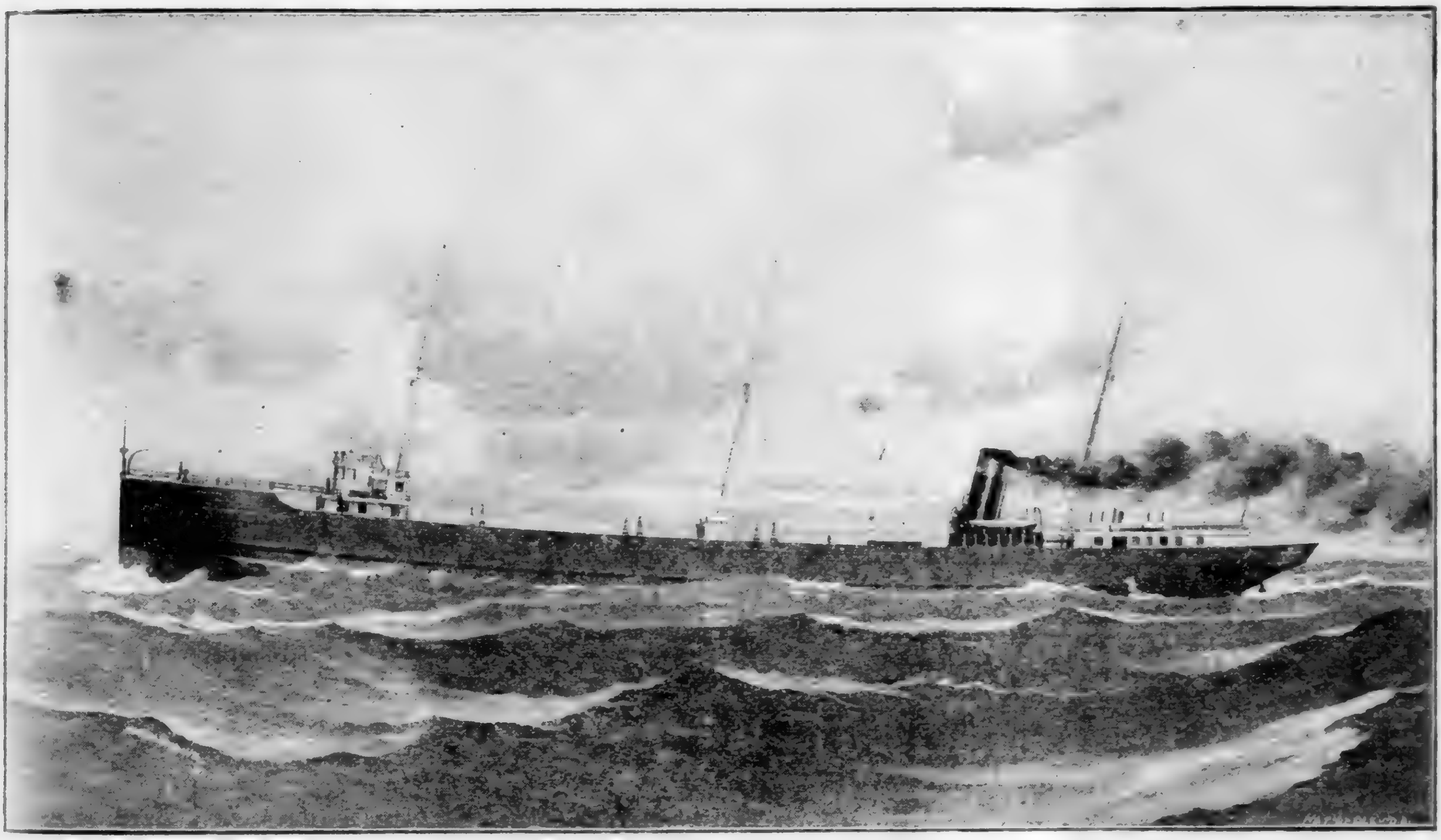

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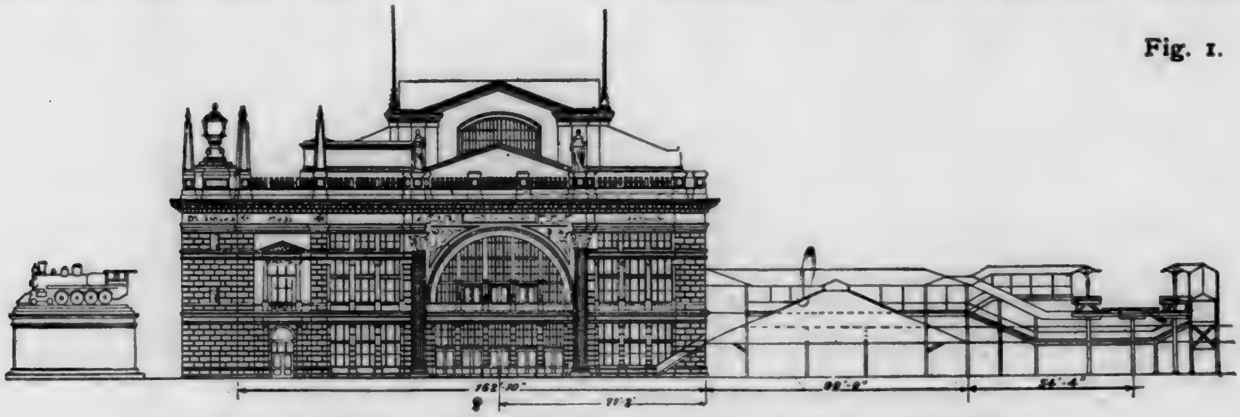
to the *Railway Review*, show the plan for the railroad station on the Exposition grounds; fig. 2 is a plan of the first floor of the station proper, with the inner end of the train-shed, the elevation being shown by fig. 1.

proper. As will be seen by this last-named drawing, the building will present a handsome exterior, fully in keeping in architectural character with the other buildings of the Exposition. To the right of this elevation will be seen the

Fig. 1.



THE RAILROAD STATION AT THE COLUMBIAN EXPOSITION.

As will be seen by the illustration, accommodations for the anticipated crowd are provided on a large scale, the depot building proper being 458 ft. in length by 162 ft. 10 in. in width, the train shed and platform covering a space 672 ft. long. As will be easily seen from the illustration, the interior is laid out with a view of convenience rather than beauty. From the northern entrance admittance is had directly into the main hall, in the center of which and immediately opposite the entrance is located, in the circular space shown, a bureau of information. At the west end of the building opening from this main hall are the men's waiting room, a general waiting hall, check rooms, etc. At the south end is located the ladies' waiting room and a large lunch room. Various rooms for the reception and checking of packages are located throughout the building. At the south side of the main hall numerous openings afford access directly to the train shed; and from thence through a series of stiles shown at the left of the train shed, entrance is had to the track. These tracks are arranged in pairs with wide platforms of 26 and 30 ft. in width between each pair of tracks, which are 48 in number.

location of one of the monumental pedestals and locomotives which are to be furnished by the Brooks and Rogers Locomotive Works respectively. These will be situated on either side of the main east entrance. They are of the mogul type, and are now being constructed especially for this purpose. It is expected that this station will accommodate 25,000 people at one time, and inasmuch as it is to be used exclusively in the excursion train service of the various railroads reaching the grounds, it is ample for the purposes designed, and with the other means of transportation provided will permit a crowd to be quickly handled.

A FULL programme has been prepared for the ceremonies attending the dedication of the Exposition buildings. The first day, Thursday, October 20, will be devoted to a procession, in which all the industries joining in the Exposition will be represented, and there will be many exhibits of a historical character.

This will be preceded, on the evening of October 19, by a reception to distinguished guests, held in the Auditorium.

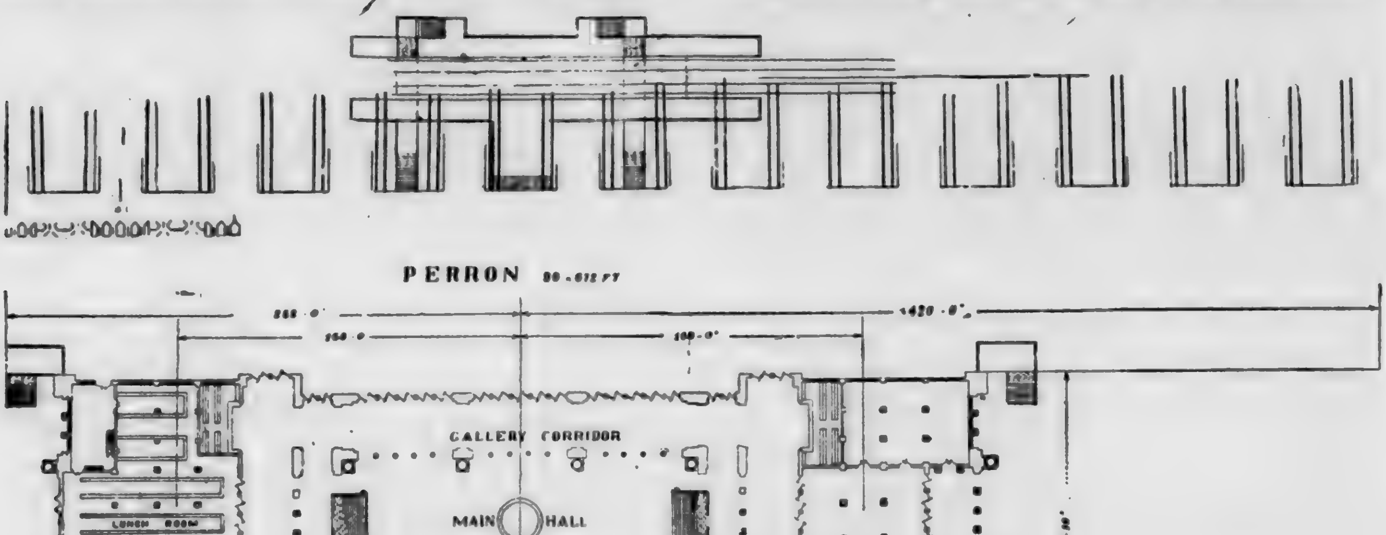


Fig. 2.

Just above these tracks, as shown in fig. 2, is the terminus of the elevated railroad, the staircases of which appear in the engraving. These terminals are also shown in the other engraving to the right of the north elevation of the station

The actual ceremony of dedication will take place on Friday, October 21, and will be of an elaborate character.

The ceremonies will close with a military parade on Saturday, October 22.

THE DYNAMITE CRUISER "VESUVIUS."

THE accompanying illustration is from a photograph of a vessel whose exact position in the Navy does not seem as yet to be fully determined. The *Vesuvius* was built to carry pneumatic guns discharging shells loaded with dynamite, of the type invented by Captain E. L. Zalinski. Some experiments have been made with the ship which seemed to show that she might be made successful; but they have not been continued, nor has the building of a sister ship been proceeded with, though authorized by law.

The *Vesuvius* differs from all other vessels in the fact that the pneumatic guns are fixed in her hull, and she is in effect a floating gun carriage, the pointing of the projectiles depending entirely upon the movements of the ship. For this purpose, of course, a swift vessel, easily and quickly handled, is required; and these conditions may be said to have been filled in her design.

As to dimensions, the *Vesuvius* is 246 ft. 3 in. long, 26 ft. 6 in. beam, and 14 ft. 1 in. deep; the displacement is 805 tons, with a mean draft of 9 ft. 3 in. The freeboard is thus low, being only about 5 ft. She has two three-bladed screws, each driven by a triple-expansion engine having high-pressure cylinder 21½ in., intermediate, 31 in., and two low-pressure cylinders each 34 in. in diameter; all being 20 in. stroke. There are four locomotive boilers 9 ft. diameter and 19 ft. 8 in. long, with a grate surface of 200 sq. ft. In addition to the propelling engines she is furnished with an electric-light plant and with powerful air-compressors for working the dynamite guns. She can carry 140 tons of coal.

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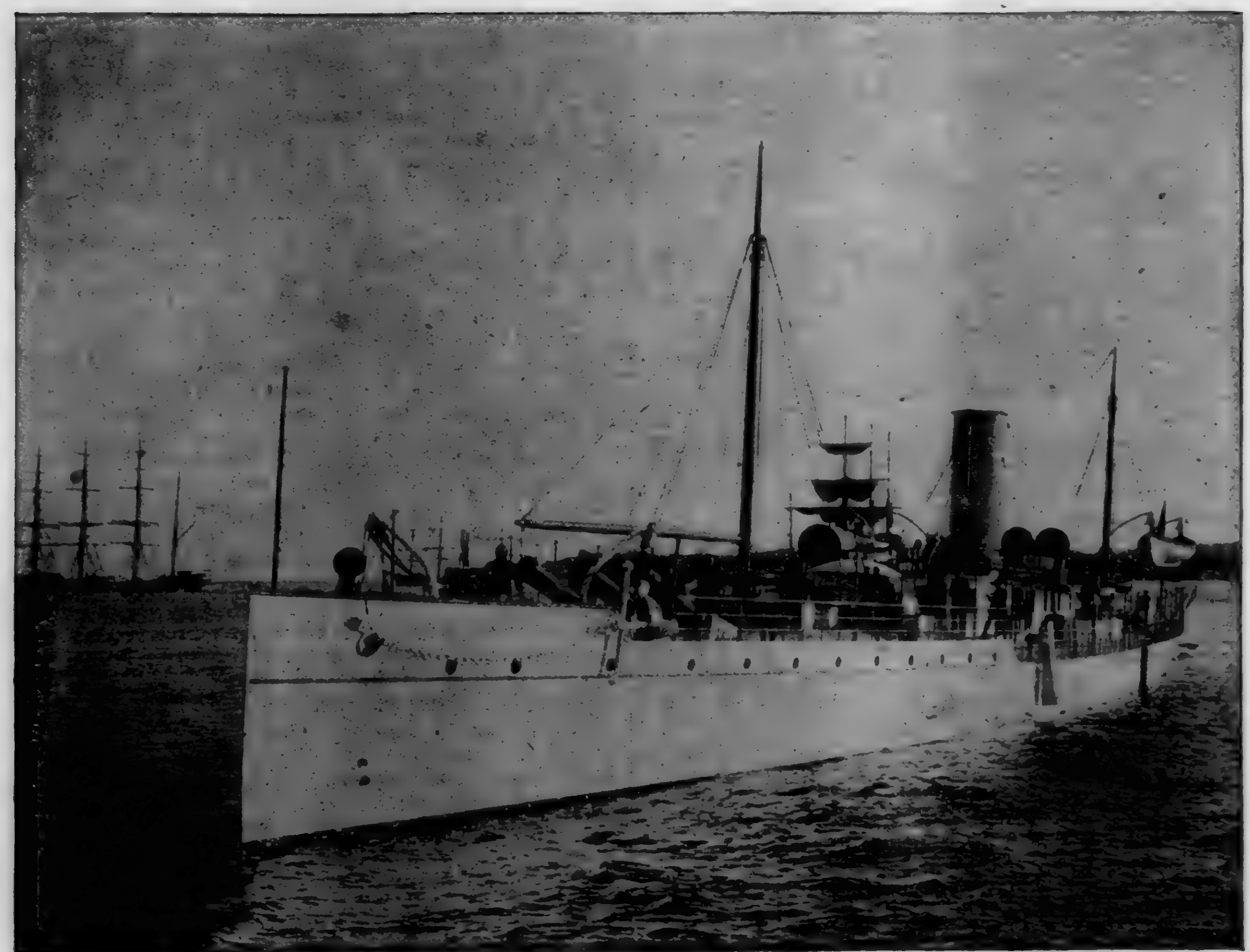
The *Vesuvius* was built at the Cramp yards in Philadelphia, and her speed has come fully up to the contract requirements. On her trial trip she attained a mean speed of 21.6 knots an hour, with 160 lbs. boiler pressure and 272 revolutions, a total of 4,450 H.P. being developed.



THE DYNAMITE CRUISER "VESUVIUS," UNITED STATES NAVY.

This vessel has attracted much attention from naval authorities, and it is to be hoped that a fuller series of experiments, which will determine her true value as a war-ship, may be undertaken as soon as possible. At present she is still somewhat of a problem, although she may be considered a success as a fast boat.

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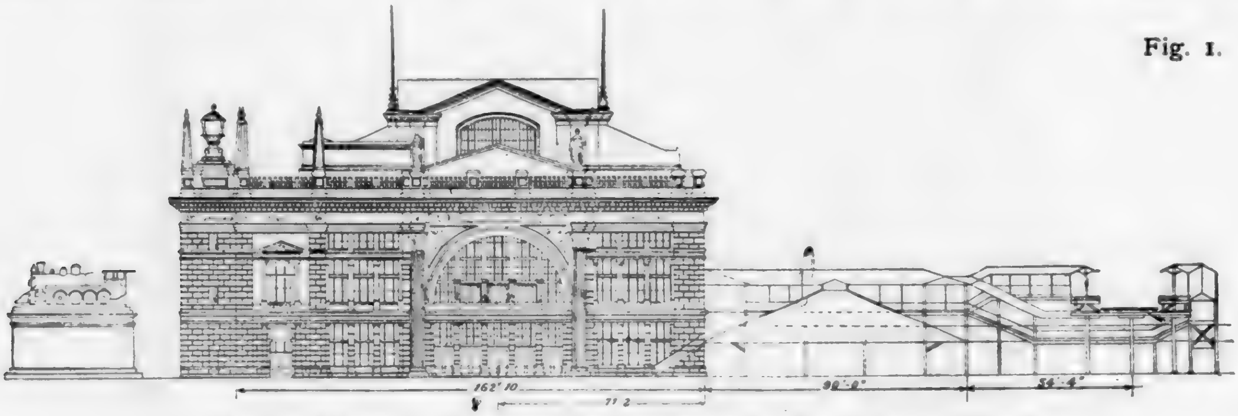
During the season of 1890 this ship was in commission 222 days, of which 175 days were passed in actual sailing, and 47 days in port. She made 30 round trips, and carried 71,171 tons of iron ore, or an average of 2,372 tons per trip. The average time spent in loading was 7¼ hours; in unloading, 12 hours. The average time re-

to the *Railway Review*, show the plan for the railroad station on the Exposition grounds; fig. 2 is a plan of the first floor of the station proper, with the inner end of the train-shed, the elevation being shown by fig. 1.

proper. As will be seen by this last-named drawing, the building will present a handsome exterior, fully in keeping in architectural character with the other buildings of the Exposition. To the right of this elevation will be seen the

Fig. 1.



THE RAILROAD STATION AT THE COLUMBIAN EXPOSITION.

As will be seen by the illustration, accommodations for the anticipated crowd are provided on a large scale, the depot building proper being 458 ft. in length by 162 ft. 10 in. in width, the train shed and platform covering a space 672 ft. long. As will be easily seen from the illustration, the interior is laid out with a view of convenience rather than beauty. From the northern entrance admittance is had directly into the main hall, in the center of which and immediately opposite the entrance is located, in the circular space shown, a bureau of information. At the west end of the building opening from this main hall are the men's waiting room, a general waiting hall, check rooms, etc. At the south end is located the ladies' waiting room and a large lunch room. Various rooms for the reception and checking of packages are located throughout the building. At the south side of the main hall numerous openings afford access directly to the train shed; and from thence through a series of stiles shown at the left of the train shed, entrance is had to the track. These tracks are arranged in pairs with wide platforms of 26 and 30 ft. in width between each pair of tracks, which are 48 in number.

location of one of the monumental pedestals and locomotives which are to be furnished by the Brooks and Rogers Locomotive Works respectively. These will be situated on either side of the main east entrance. They are of the mogul type, and are now being constructed especially for this purpose. It is expected that this station will accommodate 25,000 people at one time, and inasmuch as it is to be used exclusively in the excursion train service of the various railroads reaching the grounds, it is ample for the purposes designed, and with the other means of transportation provided will permit a crowd to be quickly handled.

A FULL programme has been prepared for the ceremonies attending the dedication of the Exposition buildings. The first day, Thursday, October 20, will be devoted to a procession, in which all the industries joining in the Exposition will be represented, and there will be many exhibits of a historical character.

This will be preceded, on the evening of October 19, by a reception to distinguished guests, held in the Auditorium.

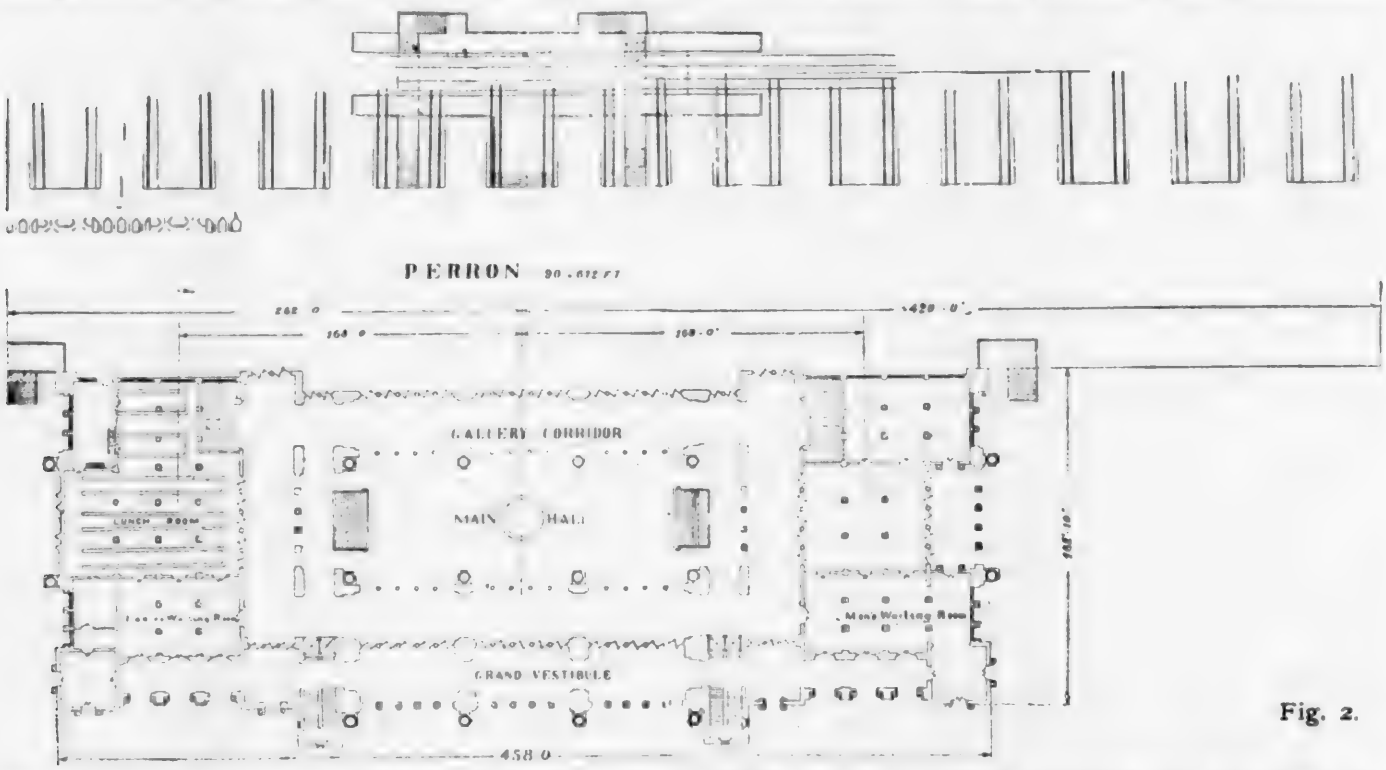


Fig. 2.

Just above these tracks, as shown in fig. 2, is the terminus of the elevated railroad, the staircases of which appear in the engraving. These terminals are also shown in the other engraving to the right of the north elevation of the station

The actual ceremony of dedication will take place on Friday, October 21, and will be of an elaborate character.

The ceremonies will close with a military parade on Saturday, October 22.

THE DYNAMITE CRUISER "VESUVIUS."

The accompanying illustration is from a photograph of a vessel whose exact position in the Navy does not seem as yet to be fully determined. The *Vesuvius* was built to carry pneumatic guns discharging shells loaded with dynamite, of the type invented by Captain E. L. Zalinski. Some experiments have been made with the ship which seemed to show that she might be made successful ; but they have not been continued, nor has the building of a sister ship been proceeded with, though authorized by law.

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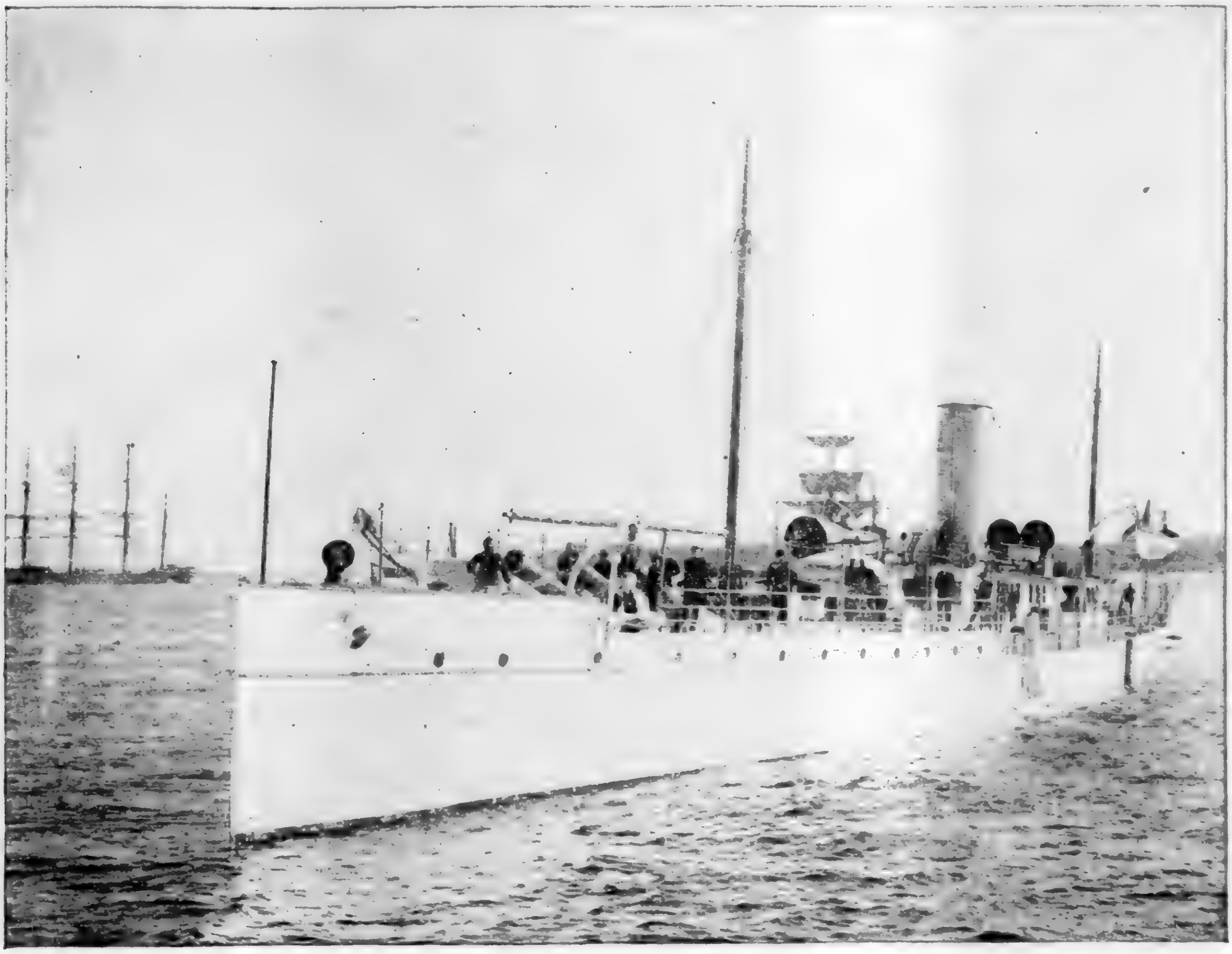

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quired for a round trip was 7 days, 9½ hours, the average mileage being 1,686 miles per trip.

The average speed of the ship was 12.72 miles per hour light and 11.85 loaded, and to attain this she burned an average of 209 lbs. of coal per mile light and 226 lbs. when loaded. She carries a crew of 23 men. The total distance traveled during the season was 50,584 miles, and the total ton-mileage of freight carried was 3,600,079. It must be remembered that cargo is carried only one way, the up trip to Lake Superior being made light.

The total earnings of the ship for the season were $93,738; the expenses were $55,114, or 58.8 per cent. of the earnings, and the net earnings were $38,624. She thus earned an average of $422 gross and $174 net per day while in commission.

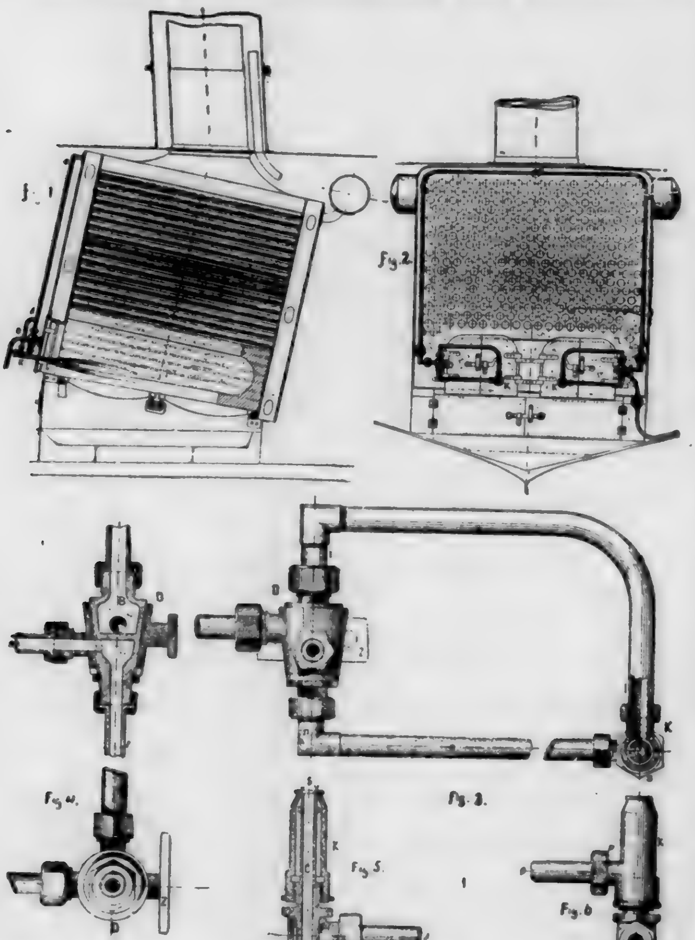
The following averages are derived from these figures:

	Per mile traveled.	Per ton carried.	Per ton mile.
Earnings	185.3 cents.	131.7 cents.	0.078 cent.
Expenses	109.0 "	77.4 "	0.046 "
Net earnings.	76.3 "	54.3 "	0.032 "

The heaviest item in the expenses was for handling cargoes, which required $16,112, or 29.2 per cent. of the total. Fuel cost $14,427, or 26.2 per cent.; labor, $10,021, or 18.2 per cent.; provisions and supplies, $3,305, or 6.0 per cent., and insurance, $5,471, or 9.9 per cent. of the total.

AN OIL-BURNING FURNACE.

THE accompanying illustrations, from *Le Yacht*, show the boiler and furnace of the French torpedo-boat *Iris*, with which numerous experiments have been made re-



OIL-BURNING FURNACE, FRENCH TORPEDO-BOAT "IRIS."

cently in burning oil, with much success. The fuel used was what the Russians call *astatki*—that is, the residuum or heavy oil left after distilling petroleum from the Baku wells.

In the engravings figs. 1 and 2 show the boiler in section and figs. 3, 4, 5 and 6 the apparatus in detail. This apparatus was put in without removing the grates for burning coal. It consists of an injector or spraying apparatus by which the oil is thrown into the fire-box in a divided state. The tubes *a* and *b* convey the oil to the upper compartment *B* of a distributor *D*, and from this it passes through the pipe *i j l* to the injector *K*. Steam taken from the boiler by the tube *A* is used to force out the oil and distribute it in a spray. The whole method will be readily understood from the drawings. The bottom of the fire-box is lined with fire-brick, to prevent injury from the flame.

In a recent trial it was found that steam was very quickly raised, the fire was very easily controlled, steam was kept at any desired point, and there was hardly any smoke. Analyses of the gases escaping from the chimney showed that the combustion was very nearly complete.

A NEW FIRE-BOX AND GRATE.

THE drawings given herewith, which are taken from the *Portefeuille Economique des Machines*, show a new fire-box and grate devised by M. Cohen, Engineer, of Paris, and which has been applied to a number of boilers in France with excellent results. In these drawings fig. 1 is a longitudinal section of the fire-box; fig. 2 shows the grate in operation as applied to a Belleville boiler; fig. 3 is a front view; fig. 4 a side view of the fire-box, while figs. 5, 6 and 7 are detailed drawings of the grate-bars.

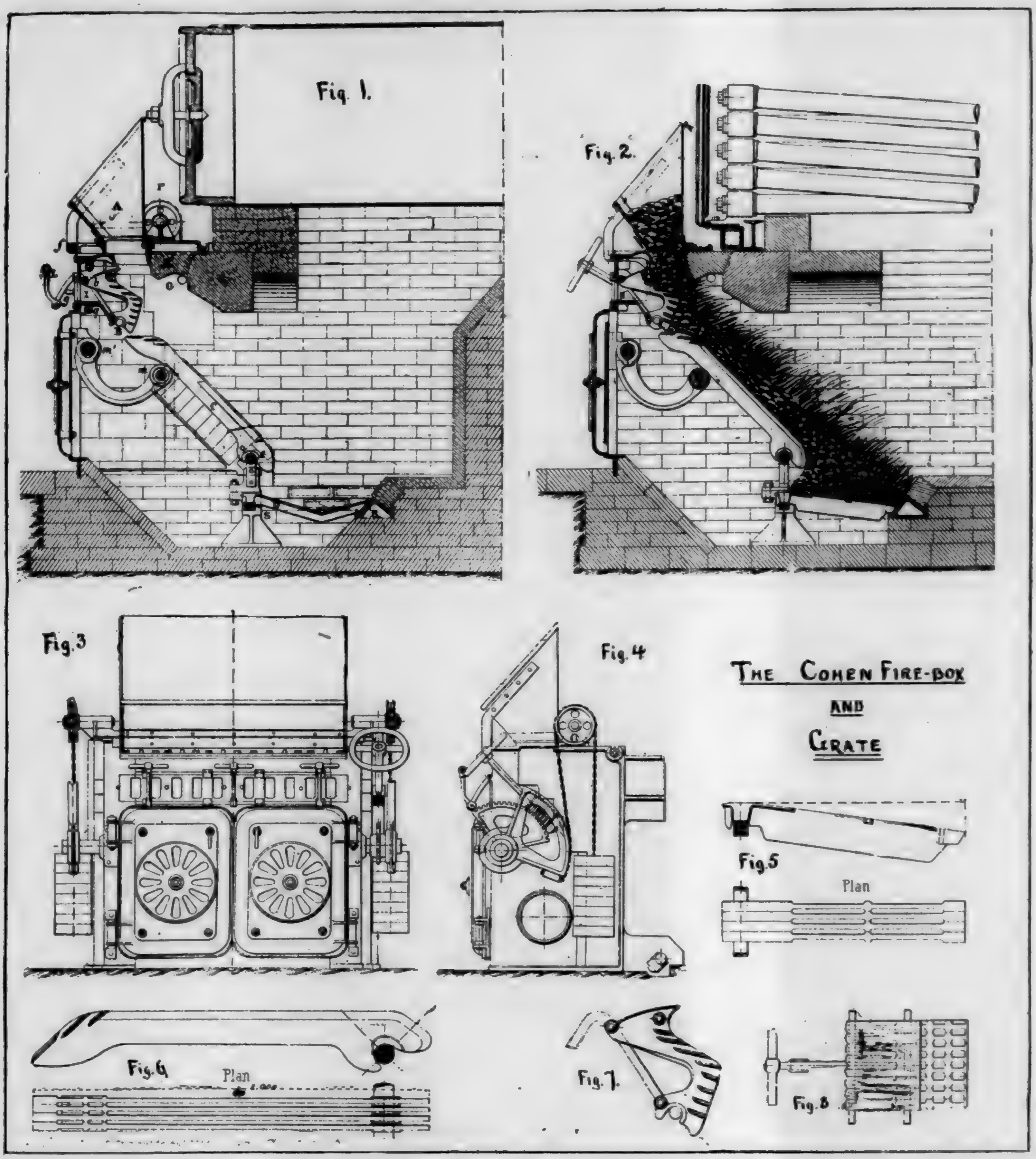
This arrangement, as will be seen from the illustrations, includes three distinct grates surmounted by a feeding apparatus at the top. The large grate, *C*, fig. 1, is inclined at an angle of about 45°, and is formed of cast-iron grate-bars, supported at the bottom by a circular bar or pivot rest, and at the top by another bar, which is carried by two cast-iron arms placed one on each side. The form adopted for these grate-bars is shown in fig. 6. They are made of considerable depth, to permit them to be kept cool by the air entering through the ash-pan. At the upper end they carry a series of lugs, which are intended not only to keep the bars at a proper distance from each other, but to prevent fine coal and coal dust from dropping through before it has been subjected to combustion.

The small grate *D* at the bottom receives the cinders and clinkers formed in the fire, and is supported at one end by the bearer *R*, which serves also to carry the fire brick composing the back of the furnace, and at the other end by the bearer *S*, which is of cast iron and is formed as shown. These bars are also shown in detail in fig. 5. To the top of the bearer *S* is also bolted the bearings, in which are carried the shaft or pivot bar upon which the large grate-bars rest at their lower end.

The upper grate *B* is composed of bars of a peculiar form, one of which is shown on a larger scale in fig. 7. The number of these is, of course, dependent upon the width of the fire-box, and they are arranged so as to be movable, resting upon the pivot *B*. A movement of rotation can be given them by means of the lever *L*, which is outside of the furnace. These bars, it will be seen, have a series of ribs upon their faces, the chief object of which is to prevent the fine coal from falling through. By moving them upon the pivot *B*, it will be seen that the opening through which coal is fed into the furnace can be increased or reduced in size, as may seem to be most expedient.

At the same height as the upper grate there is a fire-brick arch *E*, and upon each side are openings *G G*, by which air can be admitted to the furnace. Air can also enter through the bars of the upper grate by the openings *G* and under the large grate *C* through dampers placed in front of the fire-box, as shown in fig. 3. These series of openings are separated by a diaphragm, so that their regulation is entirely independent of each other.

The whole furnace is enclosed by cast-iron plates, which are lined by fire-brick. At the back end are openings leading under the boiler to the chimney, the size of which is regulated by that of the fire-box. In operation the coal is fed to the fire through the hopper *A* at the top. This has on its face two openings, through which a poker or slice can be introduced to secure the regular descent of



the fuel over the whole width of the grate, and to remove any obstruction. This feeding apparatus is carried upon pivots *f f*, so that it can be thrown back altogether when necessary. The thickness of the layer of fuel allowed to pass through the grate can be regulated by moving the upper grate bars.

Upon feeding, the coal falls first upon the upper grate *B*, and is there submitted to the heat radiated from the arch *E*, which causes a partial distillation, setting free the combustible gases, which are mixed with the air passing through the grate *B* and the openings *G*. This produces a mixture of the volatile matters with the air and puts them into a position ready for active combustion. They are drawn by the draft between the arch *E* and the burning mass of coal upon the grate *C*, and being submitted on both sides to a very high temperature, it is believed that their combustion will be almost perfect. The coal is passed through these processes of distillation, and passes over the bars *B* upon the large grate *C*, and this motion can be hastened by operating the levers *L*. In this way the rate of combustion can be, to a certain extent, regulated, and no more fuel will be thrown upon the grate *C* than can be properly burned. Upon the large grate the coal burns as in the ordinary fire-box, but the mass resting upon the small grate below prevents it from descending too quickly or from falling into the ash-pan until it is completely burned. The cinders and clinkers which fall upon the small grate *C* can easily be removed in the ordinary way.

The two arms which support the shaft *m* and the upper grate *C* are in their turn carried on another shaft *m'*, which passes through the furnace on each side. This shaft can be rotated by means of the sectors placed on each side of the furnace, as shown in figs. 3 and 4. The weight of the grate is counterbalanced by weights supported by chains and pulleys as shown, so that only a slight effort is required to move the shaft *m'*, and therefore to raise or drop the grate.

The doors leading to the ash-pan should usually be kept closed, and the admission of air under the grate can be

regulated by the registers in them. The size given to these openings should be determined by the draft of the chimney, the nature of fuel used, and the amount of steam which is to be produced.

The advantages claimed for this fire-box are the ease of regulation, the distillation of the coal and the complete burning of the gaseous products and the absence of that cooling of the fire which is experienced when the fire-door is opened to admit charges of coal. It is stated that in practice it has been found that the fire is very easily regulated by the fireman as more or less steam is required, and that in consequence the most economical rate of combustion can be maintained. It can be applied to an ordinary cylinder or tubular boiler or to any form of tubulous boiler, such as the Bellville, Babcock or others.

It is stated that in practice best results have been obtained with fine coal or with a mixture of large and small coal, such as is commonly called "run of mine." It has also been found that soft bituminous coal burns with very little smoke, which is claimed as another advantage of these furnaces.

A NEW ENGLISH BATTLE-SHIP.

THE accompanying illustration, from the London *Industries*, shows the battle-ship *Barfleur*, which was launched at the dockyard at Chatham, England, August 8. She is 360 ft. long, 70 ft. beam, 25 ft. 6 in. draft and 10,500 tons displacement. She has 12-in. side armor, 9-in. barbette armor and 4-in. armor on the upper works. Her armament will include four 10-in. guns, ten 4.7-in rapid-fire guns, 17 small rapid-fire and machine guns and seven torpedo-tubes. Her engines are expected to work up to 13,000 H.P., giving a speed of 18 knots. She has thus about the same displacement as the *Indiana*, *Massachusetts* and *Oregon*, now building for our own Navy, with somewhat lighter armor, but heavier engines.

The *Barfleur* is one of the two smaller battle-ships which were included in the English naval programme for 1889. She is a distinct retrogression, so far as regards displacement and size of armament upon the *Nile* and *Trafalgar*, and upon other battle-ships which preceded her, but in other respects she possesses attributes which give her superiority over any vessels of this character which have been previously launched, and she and her sister vessel form the first two of a prospective series which are anxiously looked for by some of the greatest nautical experts of the United Kingdom. In speed, gun command, and handiness, she surpasses any battle-ship hitherto afloat in the British Navy. The immense importance which attaches to this smaller class of iron-clad has been recognized in England, America, Germany, France, Russia and Spain. In each of these several countries the most recent steel-clad vessels are of moderate dimensions. Italy is the only country which has not responded to the almost universal demand for smaller and handier ships, and it would seem as though the Italians were determined to adhere to the larger types. It is clear that all the civilized nations of the world, with the exception of Italy, who possess a navy of considerable power, are intent upon building battle-ships not greatly exceeding 10,000 tons displacement.

The length, beam, draft, coal capacity, etc., of the *Barfleur* are given above. It may be stated, however, that the command possessed by the heaviest guns, 10-in. steel breech-loaders of 29 tons—viz., 25 ft.—is greater than that of any other ship of her class. This is an important consideration. The four guns, of which the principal armament consists, are mounted in pairs in two armored barbettes, with large arcs of horizontal training. All these guns can be fought on either broadside. Manual power can be employed for all the operation of loading or working these guns. Steam power is also provided for training the guns and hoisting ammunition. The mountings are being made by Sir Joseph Whitworth & Company. Between the barbettes are mounted two 4.7-in. quick-firing guns, and seventeen smaller guns, 6-pdrs. and 3-pdrs., are also carried. There are seven stations for ejecting torpedoes; two of these are under water, four on the broadside behind light armor, and one at the stern. A belt of armor having a maximum thickness of 12 in. protects the water-line region for about 200 ft. of the length. This belt armor is associated with a protective deck 2 in. to 2½ in. in thickness, and is completed at the extremities by armored bulkheads crossing the ship. A strong protective under-water deck runs from these bulkheads to the bow and stern respectively. Above the belt armor to the broadside is protected by light armor equivalent to a total thickness of 4 in. of steel up to the height of the main deck, which is about 9¼ ft. above water. Protection is also given to the quick-firing guns and their crews by revolving shields in fixed casemates. The hull is of steel, built on the system usually followed in the English Navy, and is minutely subdivided. Steel armor, made by Messrs. Vickers, is fitted on hull and barbettes. Wood and copper sheathing are fitted on the bottom, to prevent fouling and consequent loss of speed after long periods afloat. The ship is thus especially adapted for service on foreign stations. She is of light draft, as compared with most battle-ships of her size, and will be able to pass through the Suez Canal with a large quantity of coal on board, being in all other respects fully laden. Relatively high speed is arrived at in the design, and larger and heavier boilers than have hitherto been fitted in battle-ships have been provided, so as to secure the maintenance of speed on long distance steaming. The engines are by the Greenock Foundry Company.

The framing of the *Barfleur* is very strong. The double bottom extends right up to the armor shelf, and the depth of the web between the flanges of the framing is very great. Arched stiffeners are placed also behind the thick

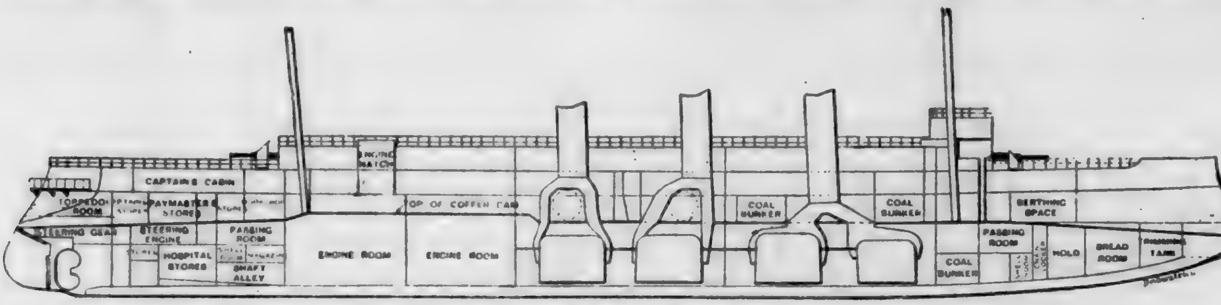


FIG. 1.—SECTIONAL ELEVATION OF VESSEL.

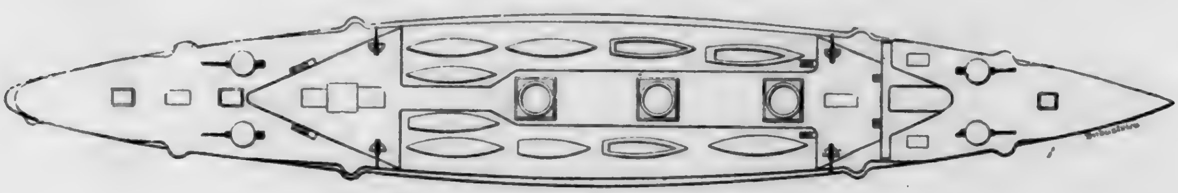


FIG. 2.—GENERAL PLAN SHOWING DISPOSITION OF ARMAMENT.

BATTLE-SHIP "BARFLEUR," FOR THE ENGLISH NAVY.

and light armor, and the coal bunkers are associated with these. The midship section is very flat across the floor. The arrangements for isolating the guns and gun crews between decks are very complete. The four 4.7-in. quick-firers in this position are provided with splinter-proof casemates of 2-in. steel, and on the outside are sponson ports, also of steel armor, which rise from the summit of the thin 4-in. steel side-armor before alluded to. There are ready-service magazines also associated with each position, into which the ammunition is served from the magazines below, and the connections between these and the casemates are armored.

The strong points claimed for the *Barfleur* as compared with corresponding iron-clads of other nations are as follows: Her speed, which will probably exceed 18¼ knots, is greater than that of any ship of her class now building, excepting the armored cruiser of Spain. The draft is very small, which will enable her to pursue the enemy into shallow harbors. The coal capacity is greater than that of any ship of the class, except those of the United States. The 4.7-in. quick-firers are of greater caliber than any others. Last, but certainly not least, there is an alternative arrangement for working the heavy guns by hand in the event of the hydraulic or steam machinery breaking down. We must not, however, fail to observe that Spain will shortly have eight of these handy armored vessels, all of greater speed and possessing heavier armament than that of the *Barfleur* and *Centurion*.

THE LOCOMOTIVE PROBLEM AGAIN.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Several answers were received to this and were published in the July and August numbers of the JOURNAL; since then some additional replies have been sent in, which are given below:

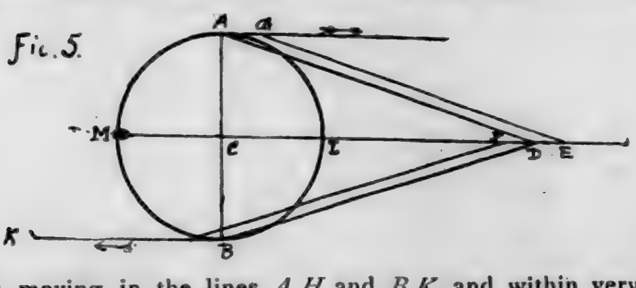
VI.—BY SETH PRATT, ASSYRIA, MICH.

Draw $A\,H$ and $B\,K$ parallel to $C\,D$, fig. 5.

It is plain that the crank-pins, when at the *highest* and *lowest* points, as at A and B, have the greatest and least forward and backward motions respectively.

Now, for an instant, these motions may be considered

Fig. 5.



as moving in the lines $A\,H$ and $B\,K$, and within very small limits; the lines $G\;E$ and $A\;D$ may be considered as equal and parallel, and consequently the sides $A\;G$ and $D\,E$ are equal. These parallelograms will diminish for equal minute times of the motion of the crank-pin, until it reaches the dead points L and M, where they vanish and the motion of the pin is perpendicular, and they begin to increase until the pin arrives at B, when the maximum retrograde motion occurs.

It may be seen, also, that the greatest effect on the piston is when the angle $A\;D\;C$ suffers the least change, and this happens when the motion of the pin is parallel to that of the locomotive, or at the points A and B, the maximum points of forward and backward motion respectively.

Putting $R =$ the radius of the wheel $= 3\frac{1}{2}$ ft.

$r =$ the distance of the crank-pin from the center,

We have

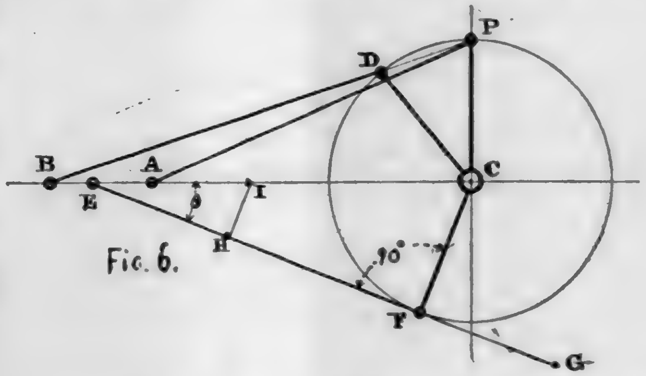
$$R : R \pm r :: 60 \text{ miles} : 60\,\frac{(R \pm r)}{R} = \begin{cases} 77\frac{1}{7} = \text{maximum} \\ 42\frac{6}{7} = \text{minimum.} \end{cases}$$

This gives $77\frac{1}{7}$ and $42\frac{6}{7}$ as the maximum and minimum respectively.

VII.—BY G. W. MACCORD, HOBOKEN, N. J.

In relation to the "Locomotive Problem," it may be pointed out that when the crank is vertical, as at $C\,P$, fig. 6, and also when it has the position $C\,D$ such that the pro-

Fig. 6.



longation of the connecting-rod $B\,D$ passes through P, the speed of the piston in the cylinder is equal to that of the crank-pin. In the intermediate positions, it is *greater*, and not less, as stated by Mr. Walker in your issue of August.

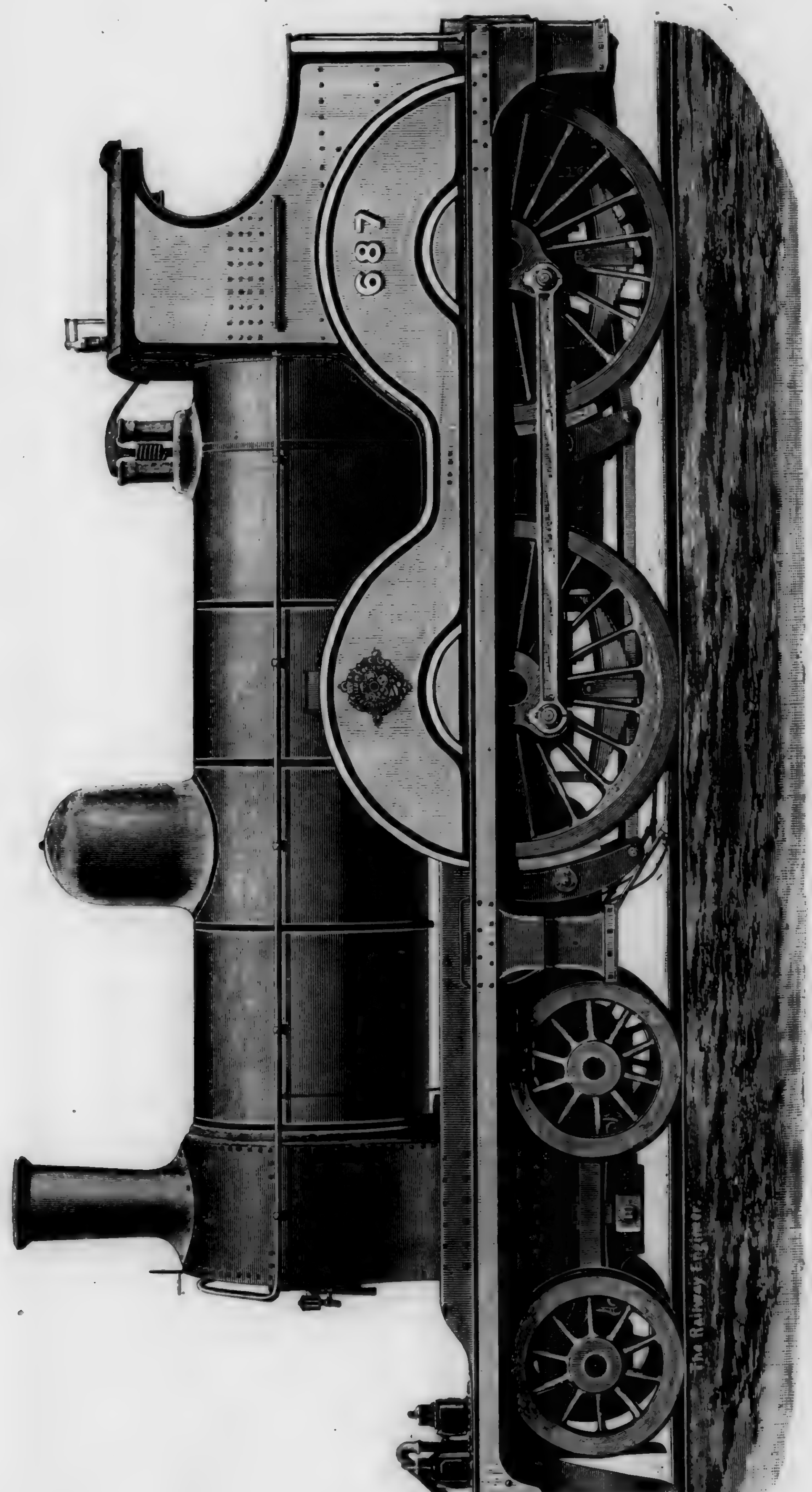
Let $F\,G$ represent the velocity of the crank-pin at F, where the crank is perpendicular to the rod. Set off $E\,H = F\,G$, and at H draw a perpendicular to $E\,F$, cutting $E\,C$ in I; then $E\,I =$ piston-speed. This is equal to crank-speed $\times$ *sec.* θ, while Mr. Walker gives crank-speed $\times$ *cos.* θ. Whether this will be the *precise* position for the maximum piston-speed, also, depends upon the relative lengths of the connecting-rod and the crank, although it will probably be very near it in all practical cases.

SOME NOTES ABOUT ANEROID BAROMETERS.

BY GEORGE L. CUMINE, C.E.

ANEROID barometers are made and sold "especially for the use of engineers," with graduations reading, by means of a vernier, to single feet. The fortunate possessor of such an instrument has been known to triumphantly measure barometrically the height of a drafting-table above the floor; but the refinements of the vernier fail too often to reduce the error in more extended measurements below a serious percentage. A perusal of Mr. Whymper's "Travels Among the Great Andes of the Equator" sheds a light on the dark places of many past barometric experiences, and affords what is probably the most valuable account of the aneroid's behavior at high altitudes yet written. The successful transport and careful observation of two standard mercurial barometers and a number of high-class aneroids throughout journeyings covering some seven months of time and a range of altitude of four miles, afforded extraordinary opportunities for comparing the behavior of the two types of instrument, and the results, as given by Mr. Whymper, cannot fail to be interesting to engineers especially.

Of eight aneroids taken by Mr. Whymper to Ecuador, six were subjected to extensive experiments at high altitudes in the interior; they were all "picked instruments, constructed expressly for the expedition," were "under trial and examination for nearly twelve months" prior to the start from London, and had "corresponded almost perfectly" with the mercurial column, when tested, inch by inch, under the air pump. Yet their performances, in comparison with the readings of two "mountain mercurial barometers of the Fortin type," for some time confounded Mr. Whymper and led him to believe that his aneroids



EXPRESS PASSENGER LOCOMOTIVE, MANCHESTER, SHEFFIELD & LINCOLNSHIRE RAILWAY.

were a bad lot. How he afterward, by a series of experiments in the workshop and comparisons of different readings, arrived at a different and more satisfactory result, is set forth in his pamphlet "How to Use the Aneroid Barometer." What follows here is culled from the book of travels first mentioned.

On the journey out to Ecuador the instruments began to differ among themselves, but the characteristics of the aneroid are best shown by some account of what occurred subsequent to the commencement of the journey into the interior. From the table, pages 412–15 of the "Travels," it appears that on December 10–12, 1879, at Guayaquil, the mean reading of eight aneroids was 29.769, when that of the mercurial barometer, reduced to 32° Fahr., was 29.824; and that on December 17, at Tambo Gobierno, the mean of the aneroids was 20.272, when the mercurial barometer gave 20.759. Thus in five to seven days a change of pressure of about 9½ in. increased the mean error of the aneroids from —0.055 to —0.487. Again, at Guaranda, during the space of seven days, the mean error of the aneroids increased from —0.520 to —0.655, and on December 30, at the second camp on Chimborazo, the mercury standing at 16.480 in., the mean error of the aneroids was —0.903. Ten days later, at this same camp, the mean error of four aneroids observed was —1.096.

The tables show that the greatest difference among the aneroids themselves generally exceeded their mean error; but an examination of the text shows that not a single aneroid fulfilled the promise of the air-pump test; thus, of two taken to the summit of Chimborazo, both presented errors exceeding an inch, and their mean reading was 12.975, while the mercury stood at 14.100, showing a difference corresponding to about 2,000 ft. of altitude.

Some of Mr. Whymper's conclusions may be summarized thus:

At diminished pressures (high altitudes) the aneroid always indicates a lower pressure (higher altitude) than the truth. When the instrument is continually subjected to diminished pressures the error continues to augment for several weeks. On restoration of the pressure the error diminishes, disappears, or changes its sign, this recovery usually occupying a longer time than that during which the instrument was subjected to the diminished pressure. Both the taking on of the error and the recovery are gradual processes, of which the first stages are the most rapid. Different instruments will develop different index-errors under similar conditions, and the amount of the error in each individual instrument will depend on the length of exposure to diminished pressure, and the extent of reduction in pressure.

The ordinary air-pump test is misleading on account of its brief duration. A "good return" to sea-level pressure after an inland journey is not necessarily proof of correct indications at high altitude on the journey.

It is consoling that Mr. Whymper does not consider the aneroid disqualified for closely approximating to differences of elevation in the diminished pressures of high altitudes, especially when the points compared are rapidly accessible one from the other. He recommends using the mean of ascending and descending rather than of several ascending or several descending observations. He describes a satisfactory experiment made with two aneroids, both of which had serious index errors, but which both gave close approximations to the truth. The difference in elevation was about 3,000 ft., and the time occupied in passing from point to point was two and a half hours. In another experiment four aneroids were carried from Quito (elevation, 9,350 ft.) up to the top of an adjoining hill and down again; of the four, three gave ascending and descending readings, differing the one from the other by, in each case, 80 ft., while the fourth gave ascending and descending readings differing by 60 ft.; the mean of the eight readings was 651½ ft., while careful measurements with the mercury had previously given 657 ft.

To the present writer Mr. Whymper's experiences appear to teach the importance of determining, so far as the aneroid is depended on, the height of a distant inland station—not by simultaneous comparisons extending over considerable periods of time of two instruments, one at sea-level, the other at the station, but from the algebraic sum of the links in a chain of results, each link being a difference in altitude deduced from readings immediately preceding and following an uninterrupted movement of the instrument at the utmost practicable speed; the joints in the chain representing points and times when the instrument was, from any cause, stationary.

It need hardly be added that all interested in the matter are advised to study Mr. Whymper's pamphlet for a full account of many interesting experiments and for deductions therefrom by the person best qualified to draw them.

AN ENGLISH PASSENGER LOCOMOTIVE.

THE Manchester, Sheffield & Lincolnshire Railway Company some time ago adopted four standard classes of locomotives to suit its traffic, and all new engines built conform to these standards. The classes are:

1. For fast passenger travel, an eight-wheel engine with four drivers coupled and a four-wheel truck, the cylinders 18 × 26 in. and the drivers 81 in.

2. For local passenger service, an eight-wheel engine with side tanks, having four drivers coupled and a bearing-axle at each end with radial bearings. The cylinders are 18 × 24 in. and the drivers 67 in.

3. For special freight service, an eight-wheel engine with side tanks, having six drivers coupled and a trailing-axle with radial bearings. The cylinders are 18 × 26 in. and the drivers 61 in.

4. For ordinary freight service, a six-wheel engine with all the wheels coupled and a separate tender. The cylinders are 18 × 26 in. and the drivers 61 in.

The accompanying illustration, for which we are indebted to the *Railway Engineer*, shows an engine of the first class, intended for fast passenger service. It has all the usual features of an English engine of this class, including copper fire-box, plate-frame, etc. The cylinders are inside.

The boiler is 51 in. diameter of barrel, and has 233 tubes 1⅝ in. in diameter and 11 ft. 0⅝ in. long. The fire-box is 64⅜ × 42 in. The grate area is 18.85 sq. ft. The heating surface is: Fire-box, 99; tubes, 1,179; total, 1,278 sq. ft. The chimney is 15¼ in. diameter; the blast-pipe nozzle, 4¾ in. The usual working pressure is 160 lbs.

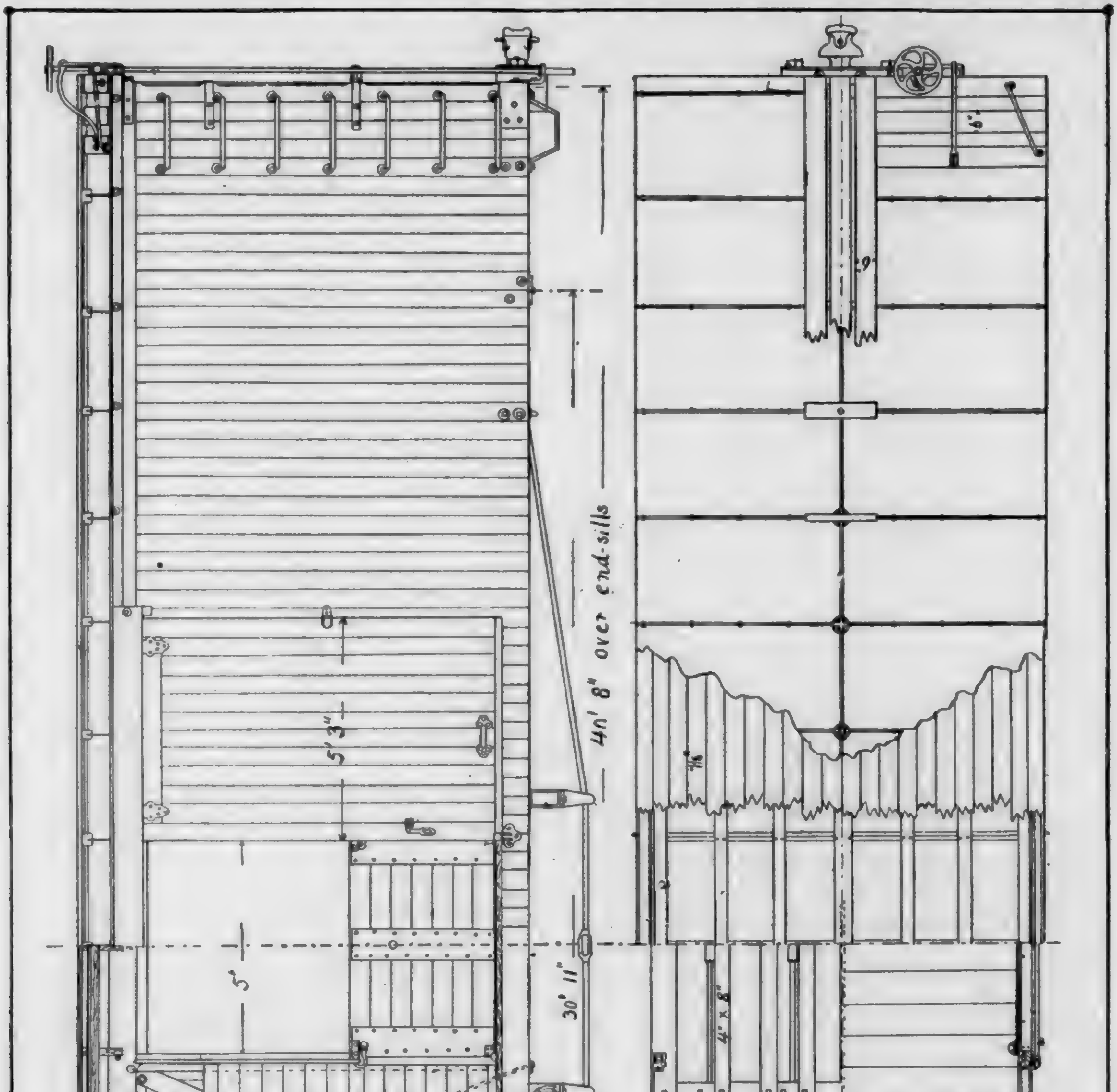
The frames are of steel plate 1$\frac{1}{16}$ in. thick. The driving-axles have 8¼ × 7½-in. journals and the truck-axles, 6¼ × 6¼ in. The truck has a plate-frame, and the axles are spaced 5 ft. 9 in. apart. The truck wheels are 42 in. in diameter. The driving-wheels are 81 in. in diameter. The driving-wheel-base is 8 ft. 7 in., and the total wheel-base, 21 ft. 9 in.

The cylinders are inside and the steam-chests are on the side, facing each other. The cylinders are 18 in. in diameter and 26 in. stroke. The steam-ports are 16 × 1⅝ in. and the exhaust-ports 16 × 2¾ in. The valves have 1 in. outside lap and 4$\frac{1}{16}$ in. maximum travel. The valve-gear is the ordinary shifting link. The eccentrics have 6¼ in. throw. The valves are reversed by a wheel and screw-motion.

The *Railway Engineer* says of the performance of these engines:

On this road the gradients are long and severe. The line is trying for a locomotive, on account of its sinuous nature (some of the curves being only 7 chains radius) and the extra flange friction, which, therefore, has to be overcome. But it is over this line that the engines make such excellent time—Manchester to Retford, 64¼ miles in 93 minutes, or to Grantham, 98 miles in 133 minutes; and in the other direction in 101 minutes and 131 minutes respectively. All these times include several stoppages.

The weight of these trains is great, as they constitute the fast service between Manchester and King's Cross, and they all have on heavy 12-wheeled dining and other saloon carriages. The dining cars weigh from 30 to 35 tons, but the weight of these trains over this section may be taken at from 120 to 220 tons, exclusive of the engine and tender, and the consumption of coal on the engines doing this work at from 22¾ to 26 lbs. per mile. These engines also work the express Cheshire lines service between Liverpool and Manchester—34 miles in 40 minutes.



STANDARD FURNITURE BOX CAR, MISSOURI PACIFIC RAILROAD.

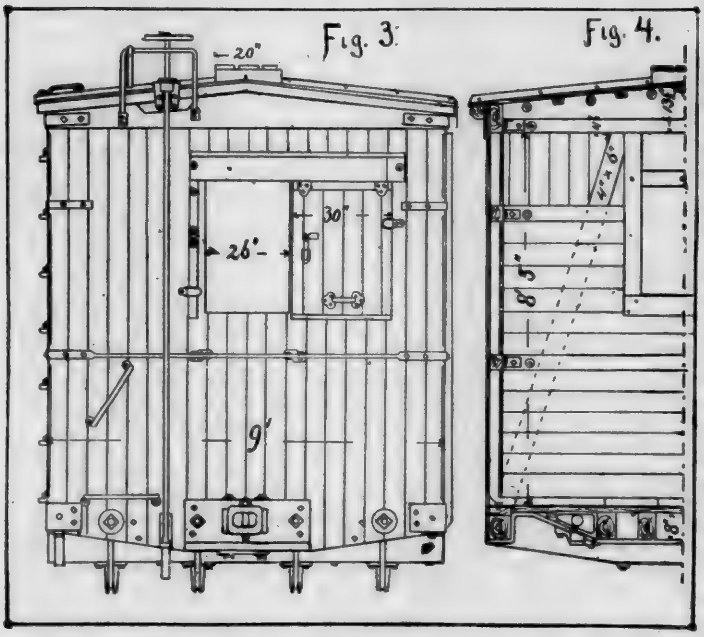
This engine has the vacuum brake, and is fitted with Gresham & Holt's steam-sanding apparatus. The boiler is fed by two Gresham injectors.

The total weight of the engine in working order is 103,040 lbs., of which 71,792 lbs. are carried on the four drivers and 31,248 lbs. on the truck.

The tank will carry 3,080 gallons of water. The tender is carried on six 45-in. wheels, and weighs 78,400 lbs., with a full load of water and coal.

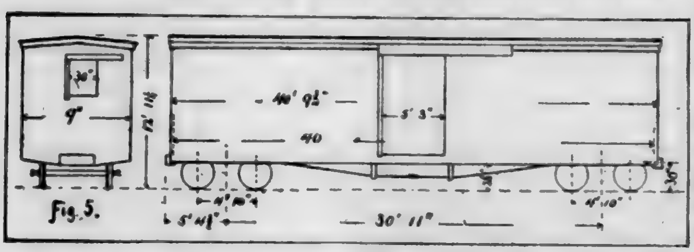
A STANDARD BOX CAR.

THE accompanying drawings show the standard furniture and buggy car of the Missouri Pacific Railroad, which, being intended for light and bulky freight, is of somewhat greater size than the ordinary box and grain car of the road. Fig. 1 is a longitudinal view, one-half in side



elevation and one-half in section; fig. 2 is a plan, one-half showing the floor and bottom framing, the other half the roof, a portion being broken away to show the roof timbers; fig. 3 is an end view; fig. 4 a cross-section; fig. 5 is a sketch showing the general dimensions.

The drawings are complete, and very little description is needed. The material used in these cars is of the best



quality of oak and pine. The cars have the Dunham car door, the McGuire grain door and the Murphy steel roof. The draw-bars are malleable iron, of the standard pattern of the road. The brakes are hand brakes, also of the standard pattern; the steps and running-board are made to comply with the standard requirements.

The trucks—not shown in the drawing—are of the pattern in use for all freight cars on this road, which was described and illustrated in the June number of the JOURNAL. They have 33-in. chilled wheels.

These cars are 40 ft. long inside, and the doors have 5 ft. clear opening, giving them a large capacity for furniture and similar freight. They are rated at 40,000 lbs. capacity, but will carry more on occasion. A large number are in use on the road, heavy orders for cars of this type having recently been filled by the St. Charles Car Company and other car works. The rolling stock of this road has been much improved in recent years, and is being gradually brought to conform with the standard types which have been adopted.

These cars were designed under the supervision of Mr. Frank Rearden, Superintendent of the Locomotive and Car Department. They are a very good example of recent practise in car building.

PROGRESS IN FLYING MACHINES.

By O. CHANUTE, C.E.

(*Continued from page* 409.)

THE writer of this record of "Progress in Flying Machines" originally hesitated whether he should include therein the account of the experiments of Captain *Le Bris*, which is about to follow. Not because he deemed it incredible in itself, nor because, if correctly stated, the experiments were not most interesting and instructive, but because the only account of them which he had been able to procure was contained in a novel, in which the author, to make the book more attractive, had mixed up a love story with the record of the aerial experiments, which combination, in the present state of disbelief, the writer feared might be too much for the credulity of the reader. It is true that the author of the novel* said that the account of the experiments was scrupulously correct, and that in this, the principal object of the book, he had endeavored to be very exact, even at the risk of detracting from his hero. It is also a fact that the *Aéronaute*,† in reviewing the book, said:

> Throughout the novel are to be found absolutely historical data concerning the artificial bird of *Le Bris*, his experiments, his partial success, his mischances, and his deplorable final failure, the latter not through a radical defect, but through lack of method, steadiness in thought, and attention to details.

But still the writer hesitated to reproduce this tale of an ancient mariner.

Fortunately, after a year's seeking, he succeeded in getting a copy of an historical book, now quite out of print, by the same author,‡ which gives without any embellishments an account of Captain *Le Bris's* experiments, and quite confirms that given in the novel, wherein it is said to have been related "with scrupulous exactness." From the historical work, therefore, of M. de la Landelle, supplemented by his novel, the following account has been compiled of what seems to have been a very remarkable series of experiments on "aspiration."

Captain *Le Bris* was a French mariner, who had in his younger days made several voyages around the Cape of Good Hope and Cape Horn, and whose imagination had been fired by the sight of the albatross, sporting in the tempest on rigid wings, and keeping up with the fleetest ships without exertion. He had killed one of these birds, and claimed to have observed a very remarkable phenomenon. In his own words, as quoted by M. de la Landelle:

> I took the wing of the albatross and exposed it to the breeze; and lo! in spite of me it drew forward into the wind; notwithstanding my resistance it tended to rise. Thus I had discovered the secret of the bird! I comprehended the whole mystery of flight.

Possessed with an ardent imagination, he early became smitten with the design of building an artificial bird capable of carrying him, whose wings should be controlled by means of levers and by a system of rigging; and when he returned to France, and had become the captain of a coasting vessel, sailing from Douarnenez (Finistère), where he was born, and where he had married, he designed and constructed with his own hands the artificial albatross shown in fig. 48.

* "Les Grandes Amours," G. de la Landelle, 1878, page 369.
† *Aéronaute*, March, 1879, page 86.
‡ "Dans les Airs," G. de la Landelle, 1884, page 210.

This consisted of a body in the shape of a "sabot," or wooden shoe, the front portion being decked over, provided with two flexible wings and a tail. The body was built like a canoe, being 13½ ft. long and 4 ft. wide at its broadest point, made of light ash ribs well stayed, and

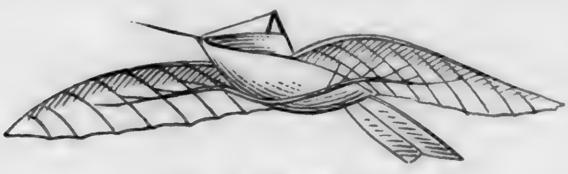


FIG. 48.—LE BRIS—1867.

covered on the outside with impermeable cloth, so it could float. A small inclined mast in front supported the pulleys and cords intended to work the wings. The latter were each 23 ft. long, so that the apparatus was 50 ft. across, and spread about 215 sq. ft. of supporting surface; the total weight, without the operator, being 92 lbs. The tail was hinged so as to steer both up and down and sideways, the whole apparatus being, as near as might be, proportioned like the albatross. The front edge of the wings was made of a flexible piece of wood, shaped like the front edge of the wing of the albatross, and to this, cross wands were fastened and covered with canton flannel, the flocculent side down. An ingenious arrangement, which *Le Bris* called his *rotules* (knee pans), worked by two powerful levers, imparted a rotary motion to the front edge of the wings, and also permitted of their adjustment to various angles of incidence with the wind. *Le Bris* was to stand upright in the canoe (an excellent position), his hands on the levers and cords, and his feet on a pedal to work the tail. His expectation was that, with a strong wind, he would rise into the air and reproduce all the evolutions of the soaring albatross, without any flapping whatever.

Le Bris's first experiment was conducted on a public road at Trefeuntec, near Douarnenez. Believing, like Count *D'Esterno*, that it was necessary that the apparatus should have an initial velocity of its own, in addition to that of the wind, he chose a Sunday morning, when there was a good 10-knot breeze from the right direction, and setting his artificial albatross horizontally on a cart, he started down the road against the brisk wind, the cart being driven by a peasant. The bird, with extended wings, 50 ft. across, was held down by a rope passing under the rails of the cart and terminating in a slip knot fastened to *Le Bris's* wrist, so that with one jerk he could loosen the attachment and allow the rope to run. He stood upright in the canoe, unincumbered in his movements, his hands being on the levers and depressing the front edge of the wings, so that the wind should press upon the top only and hold them down, their position being, moreover, temporarily maintained by assistants walking along on each side.

When they came to the right turn in the road the assistants were directed to let go, and the driver was told to put his horse on a trot. Then *Le Bris*, pressing on his levers, slowly raised the front edge of the wings to a very slight angle of incidence; they fluttered a moment, and then took the wind like a sail on the under side, relieving the weight upon the cart so much that the horse began to gallop. With one jerk *Le Bris* loosened the fastening rope, but lo! it did not run, and the bird did not rise. Instead of this, its ascending power counterbalanced the weight of the cart, and the horse galloped as if at full liberty. It was afterward ascertained that the running rope had been caught on a concealed nail, and that the apparatus had remained firmly fastened to the cart. Finally the rails of the latter gave way, the machine rose into the air, and *Le Bris* said he found himself perfectly balanced, going up steadily to a height of nearly 300 ft., and sailing about twice that distance over the road.

But an accident had taken place. At the last moment the running rope had whipped and wound around the body of the driver, had lifted him from his seat, and carried him up into the air. He involuntarily performed the part of the tail of a kite; his weight, by an extraordinary chance, just balancing the apparatus properly at the assumed angle of incidence, and with the strength of the brisk wind then blowing. Up above, in the machine, *Le Bris* felt himself well poised in the breeze, and exulted that he was about to pass two hours in the air; but below, the driver was hanging on to the rope and howling with fright and anguish.

As soon as *Le Bris* became aware of this state of affairs, and this was doubtless in a very short time, he took measures to descend. He changed the angle of incidence of his wings, came down slowly, and manœuvred so well that the driver gently reached the soil, entirely unharmed, and ran off to catch his horse, who had stopped when he again felt the weight of the cart behind him; but the equilibrium of the artificial albatross was no longer the same, because part of the weight had been relieved, and *Le Bris* did not succeed in reascending. He managed with his levers to retard the descent, and came down entirely unhurt, but one wing struck the ground in advance of the other and was somewhat damaged.

This exploit naturally caused a great deal of local talk. Captain *Le Bris* was considered a visionary crank by most persons, and as a hero by others. He was poor, and had to earn his daily bread, so that it was some little time before, with the aid of some friends, he repaired his machine and was ready to try it again.

He determined this time to gain his initial velocity by dropping from a height, and for this purpose erected a mast, with a swinging yard, on the brink of a quarry, excavated in a sort of pocket, the bottom of which was well protected from the wind. In this quarry bottom he put his apparatus together, and standing in the canoe, it was suspended to a rope and hoisted up aloft to a height of some 30 ft. above the ridge, and nearly 100 ft. above the quarry bottom. A fresh breeze was blowing inland, and the yard was swung so that the apparatus should face both the wind and the quarry, while *Le Bris* adjusted his levers so that only the top surfaces of the wings should receive the wind. When he had, by trial, reached a proper balance, he raised upward the front edge of the wings, brought the tail into action through the pedal, and thought he felt himself well seated on the air, and, as it were, "aspired forward into the breeze." At this moment he tripped the hook suspending the apparatus, and the latter glided and sailed off toward the quarry.

Scarcely had it reached the middle of the pocket, when it met a stratum of wind inclined at a different angle from that prevailing at the starting-point—a vertical eddy, so to speak—probably caused by the reaction of the wind against the sides of the quarry. The apparatus then tilted forward; *Le Bris* pressed on his levers to alter the plane of the wings, but he was not quick enough. The accounts of the bystanders were conflicting, but it was thought that the apparatus next oscillated upward, and then took a second downward dip, but in any event it finally pitched forward, and fell toward the bottom of the quarry.

As soon as the apparatus became sheltered from the wind it righted up, and fell nearly vertically; but as it exposed rather less than 1 sq. ft. of surface to each pound of weight, it could scarcely act as a parachute, and it went down so violently that it was smashed all to pieces, and *Le Bris*, who at the last moment suspended himself to the mast of the canoe and sprang upward, nevertheless had a leg broken by the rebound of the levers.

This accident practically ruined him, and put an end for 12 or 13 years to any further attempt to prove the soundness of his theory. He had failed in both experiments for want of adequate equilibrium. He fairly provided for the transverse balance by making his wings flexible, but the longitudinal equilibrium was defective, as he could not adjust the fore-and-aft balance as instantly as the circumstances changed. The bird does this like a flash by instinct; the man was compelled to reason it out, and he could not act quickly enough.

M. de la Landelle makes the following comment:

He lacked the science of Dante (of Perugia), but he was ingenious, persevering, and the most intrepid of men. He was entirely in the right in locating himself upright, both arms and legs quite free, in an apparatus which was besides exceedingly well designed. None was better fitted than he to succeed in

sailing flight (*vol-à-voile*) in imitation of his model, the albatross.

In 1867 a public subscription at Brest enabled *Le Bris* to build a second artificial albatross, and this is the one represented by fig. 48. It was much like the first, but a trifle lighter, although a movable counterweight was added, intended to produce automatic equilibrium. The apparatus when completed was publicly exhibited, and attracted much attention; but the inventor no longer had the audacity of youth, and he was influenced by numberless contradictory counsellors. He wanted to proceed as at Douarnenez, by giving an initial velocity to his apparatus, but he was dissuaded from this. He was also urged to test his machine with ballast, instead of riding in it himself, which at once changed all the conditions of equilibrium, as there was no longer command over a varying angle of incidence, and yet a first mischance led him to resort to the method of experimenting without riding in the machine.

M. de la Landelle relates it as follows:

Once only did he obtain something like an ascension, by starting from a light wagon, which was not in motion. He was on the levee of the port of commerce at Brest, the breeze was light, and the gathered public was impatient, through failure to realize that success depended wholly on the intensity of the wind. *Le Bris* was hoping for a gust which should enable him to rise; he thought it had come, pulled on his levers, and thus threw his wings to the most favorable angle, but he only ascended a dozen yards, glided scarcely twice that distance, and after this brief demonstration came gently to the ground without any jerk.

This negative result occasioned a good many hostile comments, and so the inventor no longer experimented in public; but he had further bad luck; the machine was several times capsized at starting, and more or less injured, being repaired at the cost of *Le Bris*, whose means were nearly exhausted. Then he tried it in ballast with varying success, and on one occasion, the breeze being just right, it rose up some 50 yds., with a light line attached, and *advanced against the wind* as if gliding over it. Very soon the line became slack, and the assisting sailors were greatly astonished, for the bird, without waver, thus proceeded some 200 yds.; but at the approach of some rising ground, which undoubtedly altered the direction of the aerial current, the bird, shielded from the wind, began settling down, without jolt, very gently, and alighted so lightly that the grass was scarcely bruised.

Encouraged by this partial success, *Le Bris* tried to reproduce the same results, but he met many mishaps, in which the apparatus was upset and injured. At last, one day, by a stiff northeast breeze, he installed his bird on top of the rising ground near which it had performed so well a few weeks before, and this time he meant to ride in the machine himself. He was dissuaded by his friends, and probably made a serious mistake in yielding to them, for the uncontrolled apparatus was not intended to adjust itself to a gusty wind.

At any rate, the empty machine rose, but it did not sustain itself in the air. It gave a twist, a glide, and a plunge, and pitched forward to the ground, where it was shattered all to bits. The wings were broken, the covering cloth of the canoe was rent to pieces, while the bowsprit in front was broken and forced back like a dart into the canoe.

The friends claimed that if the operator had been aboard, he surely would have been spitted and killed, but *Le Bris* maintained that if he had been aboard he could, with his levers, have changed the angle of the wings in time to avoid the wreck; he blamed himself for having surrendered his better judgment, and he gave way to profound despair.

For this was the end. His second apparatus was smashed, his means and his credit were exhausted, his friends forsook him, and perhaps his own courage weakened, for he did not try again. He retired to his native place, where, after serving with honor in the war of 1870, he became a special constable, and was killed in 1872 by some ruffians whose enmity he had incurred.

Le Bris had made a very earnest, and, upon the whole, a fairly intelligent effort to compass sailing flight by imitating the birds. He finally failed for want of sufficient pecuniary backing, and also, perhaps, for lack of scientific methods and knowledge, for even at that day Captain *Béléguic*, a French naval officer, had called attention to the importance of securing longitudinal equilibrium, the lack of which caused the failure of poor *Le Bris*. Had he secured this he might have succeeded far better, especially if he had adhered to his original conception as to the necessity for that initial velocity against the wind, which served him so well upon the first trial and so ill upon the second. Singularly enough, he does not seem in all his subsequent experiments to have sought to give his apparatus that forward motion of its own, which he, like Count *D'Esterno*, originally held to be indispensable. He had also proposed to carry on his experiments at sea, from a steam vessel under way, and whatever may have been the cause that made him give up this idea, it was a misfortune, for his apparatus was capable of floating, he was himself an excellent swimmer, and had he experimented from a vessel under motion not only would he have been safe, but he would have had no lack of wind to rise upon the air.

He seems, if the accounts given be correct, to have exhibited some very remarkable phenomena of "aspiration," which we shall find reproduced in one or two experiments yet to be noticed, and which the soaring birds exhibit every day to the observer, but he was baffled by the lack of fore-and-aft equilibrium.

In 1867 Mr. *Smyth* patented, in Great Britain, a combination of aeroplanes with lifting and driving screws, which is shown in end view by fig. 49. It consisted of a

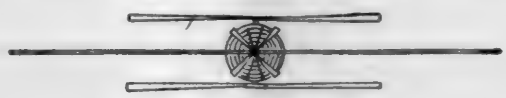


Fig. 49.—SMYTH—1867.

cylindrical car with pointed ends, to carry the passengers and the motor; of two aeroplanes, or light frames covered with silk, one at the front of the car and one at the rear, to furnish the supporting power when driven through the air by the propellers—one of which is shown in end view—and of two lifting screws, one above and the other below the car. These latter vanes were to be mounted at an adjustable angle upon vertical shafts passing through a tube in the car, the weight of the latter being transferred to them by means of a disc placed on rollers. This set of vanes was to be driven by one engine, and the horizontal propellers by another, so that the apparatus could be simultaneously lifted and driven forward if desired.

This arrangement is open to the objection that the resistance of the aeroplane has to be overcome in rising, and it is quite inferior to the proposal of *Crowell* patented in the United States in 1862, in which he had shown a pair of propellers (revolving in contrary directions), pivoted at the car, so that they might be brought overhead to ascend, and gradually dropped to the horizontal line to drive the apparatus forward, at which time a pair of aeroplanes, hinged at the car, and hanging vertically during the ascent, were also to be brought to a horizontal position to furnish a sustaining reaction.

Mr. *Smyth* seems to have apprehended that there might be some difficulty with his own arrangement, for he provides in his patent for a modification, in which he dispenses with the elevating propellers, and proposes to flap the sustaining surfaces or modified aeroplanes.

The principal feature of novelty, however, in Mr. *Smyth's* proposal was in the motor, which was to be a non-metallic apparatus, within which to explode gases to produce motion. This was to consist of a wooden cylinder, lined with a water-proof coating, and containing a series of india-rubber cells surrounded with water and connected with each other. Inside of these cells, which could be alternately collapsed or expanded, explosive mixtures of hydrogen and air were to be fired by electric sparks, the resulting expansion driving out a folding extension of the wooden cylinder, arranged like a concertina, and imparting motion to a jointed rod from which it was conveyed to the propellers.

The object was evidently to save the weight incumbent

upon metallic engines, the patentee asserting that india-rubber cells are not injured by exploding mixed gases in them, so long as they are kept moist. It is probable that experiments were made with some models of this novel motor, but no account of them seems to have been published. Mr. *Smyth* had described his proposed machine at the 1867 meeting of the Aeronautical Society of Great Britain, but had no model in the exhibition of that society in the ensuing year, where, however, an analogous idea was brought forward by Mr. *D. S. Brown*, through a model in which the ordinary cylinder and piston of a steam-engine were replaced by an india-rubber cloth bag, the alternate inflation and expansion of which produced the stroke. It was stated that the first steam-engine constructed by Hancock ran on the common road with an engine of this description, but that as the process of vulcanizing india-rubber was not then known, the steam speedily softened the texture and escaped through the canvas.

Fig. 50 shows the form of aeroplane patented in Great Britain in 1867 by *Butler* and *Edwards*, and was evidently due to some recollection of their school-boy days, when

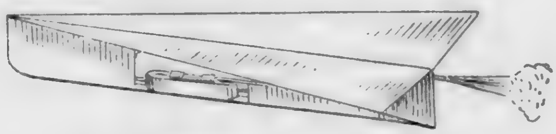


FIG. 50.—BUTLER & EDWARDS—1867.

they threw paper arrows in class. The stability of these little projectiles is quite good fore-and-aft, because the supporting surfaces increase in area while the intensity of the pressures diminish toward the rear, but the power required is great, and there is probably no aviating merit in this form. *Butler* and *Edwards* proposed to combine it in a variety of ways, superposing the sustaining planes, or placing two machines side by side, or both, and bracing between by diagonal ties. The form here shown is the simplest, the top planes being set at a slight diedral angle, in order to procure lateral stability.

The motive power was to be placed in a car, forward of the centre of figure, and capable of being moved forward and back, so as to shift the center of gravity to correspond with the center of pressure at varying angles of flight. The power was to consist in jets of steam issuing against the air in the rear; but, suspecting that this would be enormously wasteful, the patentees reserve the right of using screw propellers, driven either by the reaction of jets of steam issuing from curved arms (Hero's æolipile) or by an ordinary steam-engine, in which case the steam was to be exhausted and condensed back into water, in cells formed by doubling the surfaces of the planes and thus providing hollow spaces.

We now come to a celebrated experiment, which attracted great attention at the time; not so much because of the results obtained with the entire apparatus, for these were unsatisfactory, but because of the unprecedented lightness of the steam-engine in proportion to its estimated power.

Mr. *Stringfellow*, whose experiments in connection with *Henson's* machine have already been noticed, was much impressed with Mr. *Wenham's* proposal for superposing planes, and when the Aeronautical Society of Great Britain advertised an exhibition and offered prizes, he constructed and entered two models for competition in 1868.

One of these models was the apparatus shown in fig. 51, and consisted of three superposed planes and of a tail, driven by a screw propeller moved by a steam-engine. The aggregate frontage was 21 lineal feet and the sustaining area of the three planes was 28 sq. ft., while the tail added some 8 ft. more, thus making some 36 sq. ft. The weight, including the aeroplane, engine, boiler, fuel and water, was under 12 lbs., thus giving a proportion of about 3 sq. ft. per pound, which was certainly ample for support. The engine was rated at one-third of a horse-power, but its weight is not stated.

The machine ran suspended along a wire, in the central transept of the Crystal Palace in London. It was forced by its propellers at great speed, but generally failed to lift itself from the wire, although Mr. *Stringfellow* said that it occasionally did so, and was then sustained by its

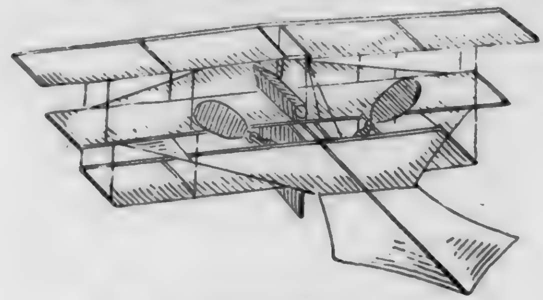


FIG. 51.—STRINGFELLOW—1868.

superposed planes alone. This failure to rise may have been due to the fact, stated by M. Hureau de Villeneuve, that the axis of the screw was parallel with the sustaining planes, so that there was no angle of incidence, but a better explanation lies in the fact that the equilibrium was so imperfect that it was not safe, for fear of breakage, to liberate the machine. This, however, was done in the basement of the Crystal Palace, after the close of the public exhibition, a canvas being held to break the fall, and M. Brearey, an eye-witness, says:

> When freed, it descended an incline with apparent lightness until caught in the canvas; but the impression conveyed was that had there been sufficient fall, it would have recovered itself. . . . It was intended at the last to set this model free in the open country, when the requirements of the Exhibition were satisfied, but it was found that the engine, which had done much work, required repairs. Many months afterward, in the presence of the author (M. Brearey), an experiment was tried in a field at Chard, by means of a wire stretched across it. The engine was fed with methylated spirits, and during some portion of its run under the wire, the draft occasioned thereby invariably extinguished the flames, and so these interesting trials were rendered abortive.

This apparatus (restored) is now in the National Museum of the Smithsonian Institution at Washington, where it is said that the engine cannot now develop anything like the power originally claimed.

The remark has well been made that so far as concerns the motive power, this apparatus ought to have flown. Its weight was only that of a goose, and it was said to have one-third of a horse-power. This may have been overestimated, but then Mr. *Maxim* estimates the power of a goose at 0.083 of a horse-power, and so there is ample margin.

There were two reasons for the failure. In the first place the sustaining surfaces were at least three times those of the goose, and hence the "drift," or horizontal component of the air pressure, would be much greater in the aggregate, so that the discrepancy in power is not as great as at first sight appears; and in the second place, and more important, the equilibrium was so defective that the inventor did not dare liberate his model, while freedom of action is the first condition of successful experiment in flight. He had done better with single planes on the previous occasion which has been mentioned, but the failure with superposed planes in 1868 does not necessarily condemn them. It merely indicates that the surfaces must be of correct shape and skilfully arranged, and, if possible, produce automatic stability. If the equilibrium be unstable, like that of the bird, it is well enough to have more power than the goose, but it is much more important to possess its skill.

The second model of Mr. *Stringfellow* consisted in a steam-engine, similar to that applied to the complete apparatus, but larger. It was entered in the catalogue thus:

> Light engine and machinery for aerial purposes, about half horse-power, cylinder 2 in. diameter, 3 in. stroke, generating surface of boiler, 3½ ft.; starts at 100 lbs. pressure in three minutes, works two propellers of 3 ft. diameter, about 300 revolutions per minute. With 3½ pints of water and 10 oz. of liquid fuel, works about ten minutes. Weight of engine, boiler, water, and fuel, 16½ lbs.

Subsequently the examining jury estimated the power at one full horse-power, the weight of the engine and boiler alone being 13 lbs., and it awarded a prize of $500 to Mr. *Stringfellow* for "the lightest engine in proportion to its power, from whatever source that power may be derived."

With this prize money Mr. *Stringfellow* erected a building over 70 ft. long, in which to experiment with a view of ultimately constructing a large machine to carry a person to guide and conduct it, his experience with models having evidently impressed him with the necessity for intelligent control of any aerial apparatus not possessing automatic stability; but he was already 69 years of age, his sight became impaired, and he died in 1883, without having accomplished any advance on his previous achievements.

A reference is made by M. de la Landelle in "Dans les airs" to an "Essay upon the Theory of Flight," published in 1869 at Copenhagen by Professor *Krarup-Hansen*, giving an account of an apparatus carrying a man who, by means of pedals, put into action horizontal wings whose action imparted motion to the machine, but the account is too scanty to determine whether this refers to beating wings or to an aeroplane.

Almost the same may be said concerning a large artificial bird, whose wings covered with feathers were more than 32 ft. across, constructed in 1845 by M. *Duchesnay* and exhibited in Paris, but which does not seem to have been tried in the open air. Somewhat more definite is the account given of some experiments by M. *Marc Seguin*, the celebrated French civil engineer, who in 1846 tried two series of experiments, one with lifting screws, and the other with an apparatus weighing 150 lbs., with a pair of canvas wings measuring 65 sq. ft. in area, from which he drew rather discouraging conclusions. He, however, tried another series of experiments in 1849, with an apparatus weighing 35 lbs. and worked by a man, the total weight, including ballast and operator being 232 lbs. This actually left the ground, and raised up some 6 to 8 in., but the effort required was evidently so violent as not to warrant further experimenting with man-power.

(TO BE CONTINUED.)

THE TRANSITION CURVE.

By W. H. Echols.

1. A car of weight W and velocity V miles per hour, in passing from the tangent to a circular curve of radius, R, has its direction suddenly changed by the impulse

$$\frac{1}{15}\,\frac{W V^2}{R},$$

causing, as the car enters the curve, a corresponding shock, which is not experienced while the car is on the curve, but is repeated as it leaves the curve for the terminal tangent.

In order to avoid this shock the deviating force must be applied gradually; and since it is not practicable to lower

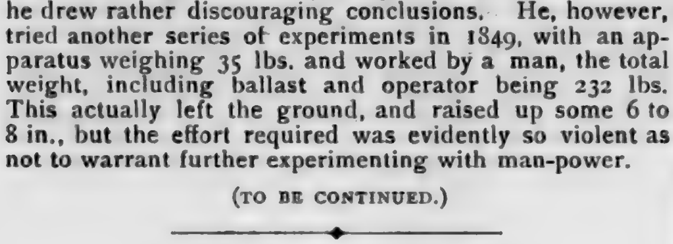


Fig 1.

the velocity, we regulate the deviating force by changing the radius. Thus, if we make the radius change uniformly (per length of curve) from ∞ to R, then the deviating force changes gradually from zero up to its full value as the car enters the circular curve.

2. If the track remain level transversely on curves, the deviating force is caused by the grinding or bearing of the wheel flange against the outer rail. In order to remove the tendency of the flange to climb the rail and the train therefore to leave the track, the road-bed must be given an inclination transversely such that the resultant of the reaction of the deviating force and the vertical weight of the car is perpendicular to the road-bed. The car will then have no tendency to leave the track.

In order to determine this inclination, say θ, let F be the horizontal reaction of the deviating force, and let W be the weight of the car. Then, in order that there may be no tendency to slide up the plane due to centrifugal force, or to slide down the plane due to gravity, we must have the components of these two forces parallel to the inclined plane equal. Hence

$$F \cos.\ \theta = W \sin.\ \theta,$$

or,

$$\tan.\ \theta = F/W.$$

Since F is small compared with W, the angle θ is also small, and therefore nearly enough equal to its tangent, sine, or circular measure.

$$\therefore \tan.\ \theta = H/G = F/W.$$

Where H is the super-elevation of the outer rail, and G is the gauge of the track,

$$\therefore H = \frac{1}{3}\,\frac{V^2}{R} = 0.000055\ V^2 D,$$

D being the degree of curve at any point.

With the increasing tendency to fast time, the super-elevation should be designed with reference to a velocity of 30 miles per hour, which gives for H at any point of a curve where the degree is D, ½ tenth per degree of curve, or,

$$H = \frac{1}{20} D.$$

The super-elevation should begin with zero at the $P\,C$ and increase uniformly up to its full value at the beginning of the circular curve D.

If S be the length of the transition in feet, then we have for the grade of the outer rail relative to that of the inner rail

$$g = H/S.$$

It is the maximum admissible value of g that regulates the length of the transition curve. Let us suppose that g is this maximum value.

3. Design of the transition.

Let D be the degree of the main curve, beginning at $P\,C\,D$, radius R.

Let s be the distance in feet and l in chains of a point A, on the curve from $P\,C$ measured along the curve.

Let θ_0 be the angle in degrees between the long chord c and the initial tangent.

Let ϕ_0 be the angle which the tangent at A makes with the initial tangent.

Let ψ_0 be the angle between the chord c and the tangent at A.

Let δ and ρ be the degree and the radius of the transition at A, and let R_1 be the radius of a one degree curve.

Let the capital letters Θ, Φ, Ψ, S, L, etc., have like meaning for the terminal point $P\,C\,D$ of the transition.

Let y be the offset in feet from the initial tangent to A, at a distance x feet from $P\,C$ along the tangent.

Let B be the point of contact of a tangent parallel to the initial tangent touching the main curve produced backward.

Let p be the offset of B from the initial tangent at a distance q from $P\,C$ along the tangent.

The fundamental property of the transition is

$$\delta = \frac{R_1}{\rho} = ms,$$

where m is a constant which must be determined to suit the practical conditions of the problem, dependent on g, since § 2,

$$m = 20\,g.$$

We have,

$$d\phi = \frac{ds}{\rho} = \frac{ms\ ds}{R_1}.$$

$$\therefore \phi = \frac{ms^2}{2\ R_1}.$$

Or in degrees

$$\phi_0 = \frac{ms^2}{200} = \frac{100}{2}\ ml^2.$$

Also

$$dy = ds\ sin.\ \phi = \phi\ ds,$$

$$= \frac{ms^2}{2\ R_1}\ ds.$$

$$\therefore y = \frac{ms^3}{6\ R_1},$$

the error being only,

$$+ \frac{m^3 s^7}{42\ R_1^3}.$$

And,

$$dx = ds\ cos.\ \phi = ds\ (1 - \tfrac{1}{2}\phi^2).$$

$$\therefore x = s,$$

the error being only,

$$+ \frac{m^2 s^5}{10\ R_1^2}.$$

Also,

$$tan.\ \theta = \theta = \frac{y}{x} = \frac{ms^2}{6\ R_1} = \tfrac{1}{3}\ \phi.$$

And,

$$\psi_0 = \phi_0 - \theta_0 = 2\ \theta_0.$$

The tangent distance for locating $P\ C$ is

$$T = (R + p)\ tan.\ \tfrac{1}{2}\ I + \tfrac{1}{2}\ S,$$

I being the angle between initial and terminal tangents.

For, see Fig. 1,

$$u = R\ \Phi = \frac{R_1}{ms}\ \frac{ms^2}{2\ R_1} = \tfrac{1}{2}\ S = q.$$

And

$$v = u^2/2\ R.$$

Therefore,*

$$p = \tfrac{1}{4}\ Y.$$

The external of the curve with the transition is longer than that of the simple curve without the transition by an amount,

$$p\ sec.\ \tfrac{1}{2}\ I.$$

The length of the main curve of D degree, is in chains,

$$ID - L.$$

The length of the whole curve from $P\ C$ to $P\ T$ being

$$I D + L.$$

4. Applications.

We distinguish between first-class roads in good country whose maximum curvature is about 8°, and whose maximum grade does not exceed 1'.5 per station, and those roads in bad country whose maximum curvature may be 16° or over, and maximum grade 3 per cent.

In the first case, the value g, the maximum admissible grade of the outer rail over that of the inner rail should not exceed 0.2 per station. And in case of the latter, g should not exceed 0.3.

5. The following is the design for roads of maximum curvature, of say 8° :

$$g = \tfrac{2}{10}\%, \text{ then } m = \tfrac{3}{100}.$$

Therefore

$$S = \tfrac{100}{3}\ D, \qquad L = \tfrac{1}{3}\ D,$$

$$x = s, \qquad \theta_0 = \tfrac{1}{3}\ l^2,$$

$$y = \tfrac{7}{8}\ l^3, \qquad \psi_0 = 2\ \theta_0,$$

$$T = [R + (\tfrac{3}{10}\ D)^2]\ tan.\ \tfrac{1}{2}\ I + \tfrac{1}{2}\ S.$$

[1] This is the transition curve suggested by me in the publication of the Missouri School of Mines, June, 1890, and developed by Professor H. H. Talbot in the University of Illinois, *Technograph*, 1891.

To run in a D degree curve, measure off T and locate $P\ C$, set up there and run the transition curve in with the deflections $\theta_0 = \frac{1}{3}\ l^2$. To recover the tangent at any point, deflect from the chord the angle $2\ \theta_0$. Of course the curve may be put in with the offset $y = \frac{7}{8}\ l^3$, and $x = s$, if preferred.

To run the transition in backward—that is, from $P\ C\ D$ to $P\ C$—as is required at the end of the main curve. Deflect from the tangent at $P\ C\ D$ the angle

$$\theta_0' = L^2 - \tfrac{1}{3}\ (L - l')\ (2\ L - l'),$$

in order to set a point at a distance, l', chains from $P\ C\ D$. Easily proved by considering the triangle with vertices at $P\ C$, A, and $P\ C\ D$, remembering that the angles are small and therefore proportional to their sines.

6. If the maximum curvature be 16°, we may put

$$g = \tfrac{3}{10}\%, \qquad \therefore m = \tfrac{6}{100}.$$

The formulæ for doing the work are as before,

$$\theta_0 = l^2, \qquad x = s, \qquad L = \tfrac{1}{6}\ D,$$

$$\psi_0 = 2\ l^2, \qquad y = \tfrac{7}{4}\ l^3,$$

$$T = [R + 2\ (\tfrac{1}{10}\ D)^2]\ tan.\ \tfrac{1}{2}\ I + \tfrac{1}{2}\ S.$$

$$\theta_0' = 2\ L^2 - (L - l')\ (2\ L - l').$$

7. It does not seem possible to get simpler formulas. In no case, for the maximum curves, will these formulas give an error of as much as one-half of one-tenth of a foot, or one-half of one minute of angle.

CROSSINGS OF GREAT RIVERS.

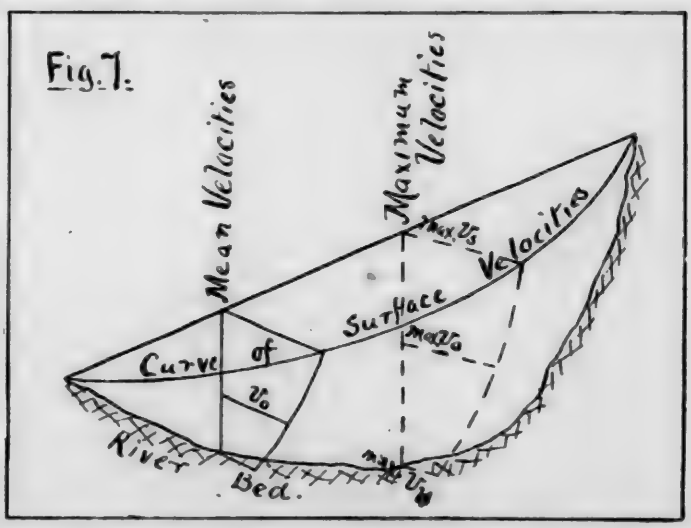
A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

(*Continued from page* 404.)

WATER-LEVELS.

Besides the observations of water-level, made during the time of survey and location, it is necessary to collect the observations made at the neighboring water-gauge stations (if any have been established), and to get from the country people information as to the height of the highest floods and the levels of the ice running in spring and autumn. Sometimes it is possible to find on the shore the marks or traces of the highest level and of the ice running.



The information concerning the limits of spring and autumn ice running, and of the thickness and force of the

ice and the character of its running—as in large cakes or broken up—are especially important, being necessary for the proper design of the ice-breakers of the piers.

For the result there should be given the heights of the following levels:

1. The lowest (in summer or autumn).
2. The highest (in spring).
3. The lowest level of the autumn ice.
4. The highest level of the spring ice breaking up and running out.

It is also necessary to get information concerning the usual time of freezing and of breaking up of the ice, and the duration of the spring and autumn ice running.

NAVIGATION AND VESSELS.

As the designed bridge should not hinder the existing navigation, information concerning the character of it, and especially information on the dimensions of vessels, their draft and height of superstructure—cabins, chimneys, etc.—should be collected with great accuracy.

RECAPITULATION OF DATA.

The investigation of a river crossing is complete when the following data have been obtained:

1. The value of the maximum discharge of river near the site of the proposed bridge, and the value of the corresponding mean velocity (being equal to the maximum velocity on the bottom).
2. The topographic plan of the portion of the river near the site of the bridge, with the lines of equal depth, the horizontals of shores, and the directions of currents.
3. The transverse profile of the river along the line of the bridge, with evidence of the kind of ground to the necessary depth—that is, to solid ground, or even to 75 or 100 ft. below the low-water level.
4. Information about the different water-levels—viz., low, high, and that of the spring and autumn ice, and information about the dimensions of the ice.
5. Information about the navigation and the dimensions of vessels.

GENERAL DESIGN OF THE BRIDGE.

All the above enumerated data are quite sufficient for the general design of the bridge; for, having them, it is possible to determine the chief elements of the design, or to state the chief conditions of the design for the bridge—viz.:

1. The minimum clear opening.
2. The depth of foundations of abutments and piers.
3. The elevation of the superstructure above the water-level.
4. The most economical and convenient distribution of spans and piers.

DETERMINATION OF CLEAR OPENING.

From the given maximum discharge of the river, the total clear opening of the bridge can be determined in two suppositions: 1. That washing out or scouring of the bed is *not* allowed; and, 2. Allowing this washing out of the river-bed to any fixed depth.

I. *The washing out of bed not considered.*—If we call, for the highest water-level,

Q = the maximum discharge,
w = the corresponding area of cross-section, and
v = the mean velocity of the water,

then, as above stated, we have

$$Q = w\,v.$$

After the construction of a bridge, the area of cross-section and the mean velocity may be different; and we may call them w_o and v_o.

The value of w_o is determined in the following manner: Take the transverse profile of the river at the site of the bridge, and draw on it the elevation of the bridge as designed; then from the area of the cross-section w—the area delineated by the line of highest water-level and the wetted perimeter of the bed—subtract the area of the immersed portions of piers, abutments and rip-raps. The difference will approximately give the value of w_o.

The quantities w_o and v_o should satisfy the equation

$$Q = \mu\,w_o\,v_o,$$

where μ is the co-efficient of contraction, depending upon the form of piers in the plan:

For quadrangular form, $\mu = 0.85$
" semicircular " $\mu = 0.90$
" acute angle " $\mu = 0.95$

From the equation $Q = \mu\,w_o\,v_o$ we deduce

$$v_o = \frac{Q}{\mu\,w_o},$$

and as $\mu < 1$ and $w_o < w$, therefore we always have $v_o > v$. This increase of the mean velocity is accompanied by an increase of the surface velocity and the bottom velocity. The former of them, when too great, may hinder the navigation; the latter, when beyond a certain limit, may wash out the subsoil and injure the foundations.

As the mean velocity of the given cross-section is equal to the average velocity of a certain vertical, therefore with a sufficient approximation it can be assumed that the surface velocity and bottom velocity in that vertical will be equal to the mean surface velocity and the mean bottom velocity of the whole cross-section (see fig. 7). Consequently these quantities are given by the series of preliminary observations.

In order to get the maximum surface velocity v_s and the maximum bottom velocity v_b we take from observations the maximum average velocity in a vertical (the average velocity in the vertical of maximum velocities), and from that maximum average velocity, which we call v_{max}, we calculate the required velocities v_s and v_b by means of the well-known formulas of Weissbach, Lohmeyer and Eytelwein.

According to Weissbach's formula, the maximum surface velocity,

$$_{max}v_s = \frac{v_o}{(0.915)^2} = \frac{v_o}{0.83},$$

and the maximum bottom velocity

$$_{max}v_b = 0.83\ _{max}v_s = v_o.$$

According to Lohmeyer's formula (in meters),

$$_{max}v_b = (0.8617 - 0.469\,k)\ _{max}v_o,$$

where k is the value of the rise of water caused by the bridge.

According to Eytelwein's formula (in feet),

$$_{max}v_b = {}_{max}v_o\,(1 - 0.0075\,k).$$

The value of the maximum bottom velocity $_{max}v_b$ may be calculated by means of all these three formulas, and taken at the average of the results.

This calculation is satisfactorily exact when the value of the rise of water (k) is insignificant, which is generally the case, the value of k in ordinary conditions being not more than a few inches. On the contrary, when the value of k is of some importance, the bottom velocity should be increased by the quantity depending upon the head of the layer of water of thickness $= k$, and this increment of velocity will be expressed by the formula

$$v_b' = \sqrt{2\,g\,k + v_b^2}.$$

Having thus calculated the maximum bottom velocity, it is necessary to compare it with the velocity at which the washing out or scouring of the bottom soil begins.

The velocities at which the washing out of different kinds of ground begins are shown in the following old and well-known table:

Description of ground.	Velocity in feet.
Loam	½
Clay	1
Clay with sand	2
Gravel	4
Coarse gravel (hard pan)	5
Pudding, or conglomerates	7
Stratified rocks	9
Solid rocks	14

The figures given in this table should be considered as too small, for the observations of velocities in existing bridges have shown that a bottom velocity of 5 to 6 ft. does *not* wash sandy beds, especially when such velocities do not last a long time.

Instead of using the above table, the maximum value of the bottom velocity, which can be allowed in every special case, can be determined by the following method: Take, from the observations, the maximum bottom velocity in the uncontracted main channel, and at its deepest point; it is obvious that this velocity does *not* wash out or scour the bed, and, therefore, it can be taken as the maximum bottom velocity to be allowed in the contracted channel; the more so that here the distribution of velocities along the cross-section is more regular than in the uncontracted channel.

If the value of maximum bottom velocity $({}_{max}v_b)$, calculated by the formulas given above, is found greater than the maximum bottom velocity allowed from table or observation, then it is necessary either to increase the area of the contracted cross-section, or in some way to protect the bottom. The increase of the area of cross-section can be made either by enlarging the clear opening, or, when the required increase is small, by cutting out the bottom and giving it a regular form.

Having so arranged that the bottom velocity will not wash out the bottom, it remains to prove whether the surface velocity will not hinder the navigation. This velocity should not exceed certain limits, depending upon the nature and character of navigation. According to Debauve, the upward navigation is difficult when the surface velocity is $3\frac{1}{2}$ ft. per second, and the downward navigation when the surface velocity is $5\frac{1}{4}$ ft. per second.

It remains to calculate the value of the rise of water occasioned by the bridge. For that purpose, we take three cross-sections of the river—above the bridge, on it, and below it—and we call by

w' the area of cross-section above the bridge,
w_o " " " under the bridge,
w " " " below the bridge,

and by v', v_o and v the corresponding mean velocities.

Assuming that the form of cross-section in these three profiles is the same, and calling the width of the river L, and the rise of water k, we have

$$w' = w_o + L\,k.$$

And as

$$k = \frac{v_o^2 - v'^2}{2g}$$

and

$$(w + L\,k)\,v' = \mu\,w_o\,v_o = w\,v,$$

therefore

$$v_o = \frac{w\,v}{\mu\,w_o}, \quad v' = \frac{w\,v}{w_o + L\,k},$$

and finally

$$k = \frac{w^2\,v^2}{2\,g}\left(\frac{1}{\mu^2\,w_o^2} - \frac{1}{(w + L\,k)^2}\right).$$

We see that the value of k enters into the second member of this equation, and therefore it should be calculated by consecutive approximations, beginning from $k = 1$ or 2 in.

II.—*The washing out or scouring of bed being considered.*—Suppose that the washing out of bed or scouring is allowed to a certain depth defined by the following conditions:

1. Thickness of earth layer above the base of foundation, which is necessary for the stability of abutment or pier.
2. Depth of the river.
3. Greatest possible depth of sinking the foundation with given means and in the given circumstances.

If we call these quantities h, h' and H, then, in fig. 8, the depth of the layer which can be allowed to be washed out is given by the formula

$$a = H - (h + h').$$

Having so determined the greatest allowed depth of washing out, a, we shall assume some value of clear open-

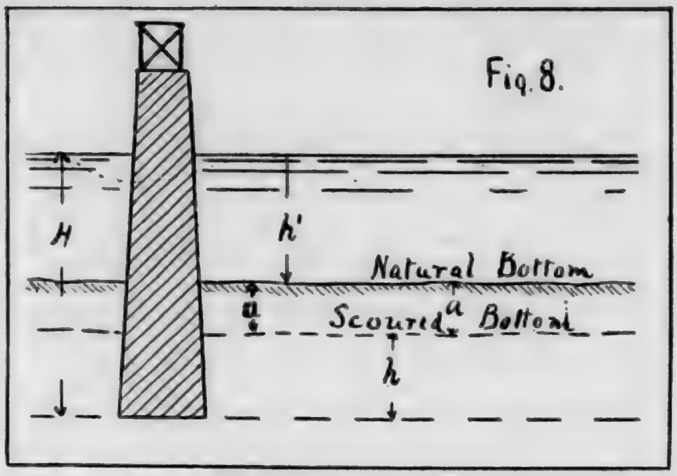


Fig. 8.

ing, say l, and verify its sufficiency by computing the washing out corresponding to that clear opening, l.

We can here distinguish two cases: 1. When the width of flood is not great and the velocities are not very different; and, 2. When the width of flood is very great (10 or more times more than the normal width of river) and the velocities in them are very different. In the first case, the discharge is given by the formula

$$Q = w\,v = L\,r\,v,$$

where L is the width of the river before the construction of bridge, r the mean depth, and v the mean velocity of water. After the contraction of cross-section of channel by the bridge, we get

$$Q = \mu\,w_o\,v_o = \mu\,l\,r\,v_o,$$

where l is the assumed value of clear opening or waterway, r = the same mean depth, and v_o the mean velocity of the contracted channel, and μ the co-efficient of contraction (0 85 — 0.90 — 0 95).

As $\mu < 1$, $l < L$; therefore $v_o > v$. Supposing that the ground of the bed does not resist this increased velocity and will be washed out, the depth and the mean depth will increase, and consequently the mean velocity v_o will diminish till the corresponding bottom velocity becomes equal to its previous value, and then

$$Q = w\,v = \mu\,l\,r'\,v,$$

where r' is the mean depth after the washing out has finished.

As $\mu < 1$, therefore $l\,r' > L\,r$; and if before the washing out the values of the mean and greatest depths were r and $r_m = a\,r$, then, assuming the same ratio after the washing out, we will have

$$r'_m = a\,r',$$

and the greatest washing out corresponding to the assumed clear span l will be

$$r'_m - r_m = d_m.$$

If this quantity (d_m) is less than the above-defined limit of permissible washing out a, then the assumed clear opening l is available; in the contrary case, the value of the clear opening l should be increased till it satisfies the condition $d_m < a$.

In the second case, when the width of flood is very great, and even when the river consists of two or more separated channels, with different velocities, then it is quite correct to suppose that the washing out of the bed will stop when the mean bottom velocity of the whole contracted cross-section becomes equal to the corresponding velocity of the main channel.

Dividing the cross-section of the flood into three channels—left, mean, and right—marked by indices 1, 2, and 3, as in fig. 9, we have

$$Q = w_1\,v_1 + w_2\,v_2 + w_3\,v_3.$$

After the construction of the bridge, and the washing out of the bed caused by it, the mean velocity will be v_2, and we will have

$$Q = \mu\, w'\, v_2 \;\therefore\; \text{the area of cross-section } w' = \frac{Q}{\mu\, v_2}.$$

If, as above, we design the clear span of the bridge by l, the mean velocity after the washing out by r', then

$$w' = l\, r',$$

and

$$r' = \frac{w'}{l}.$$

If r and r_m are the mean and maximum depths before the

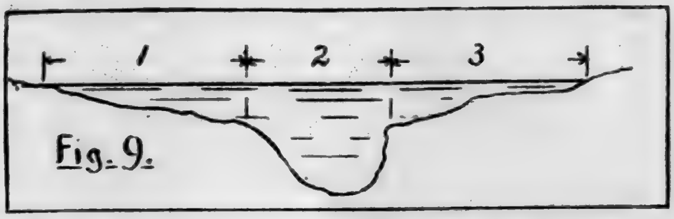


Fig. 9.

washing out, and $r_m = a\, r$, then it is very probable that after the washing out the greatest depth r' will be

$$r'_m = a\, r'$$

and the value of the washing out

$$r'_m - r_m = d.$$

The availability of l is defined by the condition that d be less than a.

If weak or soft ground extends to a depth greater than a—a limit conventionally fixed by the stability of the foundation—then the washing out will last till that moment when the velocity becomes equal to the original velocity; but when at a certain depth less than d and less than a there is stronger ground, then the washing out will not reach the depth d; the velocity under the bridge will be greater than that below it, and a rise of water will occur.

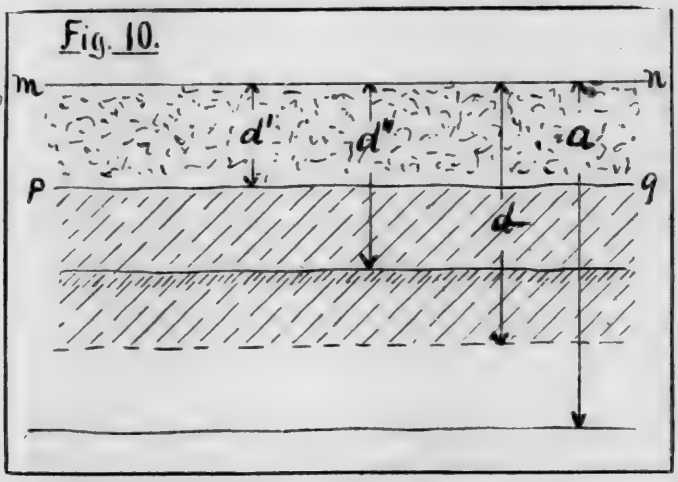


Fig. 10.

The value of this rise k can be so computed from the real washing out, d', fig. 10.

Let $m\,n$ be the river bottom, $p\,q$ the limit of soft ground, d the limit of washing out, in the supposition of uniform soft or easily scoured ground. In the beginning the ground will be washed out to the depth d'; if at that moment the bottom velocity be greater than the limiting velocity of the lower layer, that layer will be washed out to a certain depth, d'', when the bottom velocity becomes equal to that limiting scouring for that stronger ground. This quantity can be computed by consecutive approximations.

If to the depth d'' correspond the cross-section w'' and the mean velocity v'', then the rise of water is given by the formula

$$k = \frac{1}{2\,g}\left(v''^2 - v^2\right)$$

where

$$2\,g = 64.4 \text{ ft.}$$

(TO BE CONTINUED.)

THE UNITED STATES NAVY.

THE first Whitehead auto-mobile torpedo ever fired from the gun of an American war vessel in this country was shot from one of the three 18-in. torpedo-tubes of the torpedo-boat *Cushing*, at Peconic Bay, September 1. Two others were equally successful, and the guns worked to the satisfaction of the Torpedo Board. The torpedoes were 11 ft. 8 in. long and 18 in. in diameter. They were made of steel ⅛ in. thick at the forward end, and with a compressed air chamber having a capacity of 7 cub. ft. of air at a pressure of 1,350 lbs. to the square inch. It being desired to test the guns and not the torpedoes, the latter carried no gun-cotton and their propellers were not used.

THE next ship to be launched for the Navy is the *Cincinnati* at the New York Navy Yard, which is nearly ready. She is one of the 3,000-ton cruisers, and is a sister ship to the *Raleigh*, built at the Norfolk Yard, which was described and illustrated in the JOURNAL for May last.

THE plans for the new armored cruiser and battle-ship are not yet quite complete in the Navy Department, but it is expected that they will be ready about November 1, so that bids can be received by the close of the year. The general plan of both has been decided on.

The battle-ship will be for the present designated as No. 4; she will have about 1,000 tons more displacement than the three now under construction. The general dimensions will be: Length, 360 ft.; beam, 72 ft.; draft, 24 ft.; displacement, 11,250 tons; engines, 11,000 H.P.; speed, 16½ knots. The armament is not fully decided on, but will probably include four 12-in. guns, several 8-in. guns and a number of 4-in. or 5-in. rapid-fire guns.

The armored cruiser, which is to be named *Brooklyn*, will be the same type of ship as the *New York*, but somewhat longer and of 1,000 tons greater displacement. Her general dimensions will be: Length, 400 ft.; beam, 64 ft.; draft, 23 ft.; displacement, 9,150 tons; engines, 16,000 H.P.; speed, 20 knots. The armament will probably include eight 8-in. guns, twelve 5-in. rapid-fire guns, a number of smaller rapid fire and machine guns and five torpedo-tubes. She will, like the *New York*, have four engines, two for each screw, and will have a capacity for a large coal supply.

NOTES.

IT is worthy of note that the Greenland expedition of Civil Engineer Robert E. Peary, U. S. N., has returned in safety, after reaching the point furthest north to which a civilized man has ever penetrated, latitude 81° 37′. Many facts in relation to the geography of Greenland and the northern ice-belt were ascertained. Mr. Peary's original programme was fully carried out, and the only casualty was the loss of one man, whose death seems to have been due chiefly to his own recklessness.

ON September 1 there were, according to the *American Manufacturer's* tables, 240 furnaces in blast, having a capacity of 156,584 tons of pig iron weekly. This is a reduction during August of two furnaces in number, and of 1,997 tons in the weekly output. As compared with September, 1891, the capacity of the furnaces in blast shows a decrease of 18,312 tons, or about 10½ per cent. A further decrease in production hardly seems probable, as a material reduction in stocks of pig iron on hand is reported.

THE Ordnance Department of the Army has recently awarded contracts to the Bethlehem Iron Company for 12 sets of forgings for 10-in. guns; nine sets for 12-in. guns and seven for 12-in. steel mortars. The Midvale Steel

Company received contracts for ten sets of forgings for 8-in. guns; ten for 7-in. siege howitzers; ten for 5-in. siege-train guns and 25 sets for 3.2-in. field guns. The contract for steel armor-piercing projectiles has not been awarded.

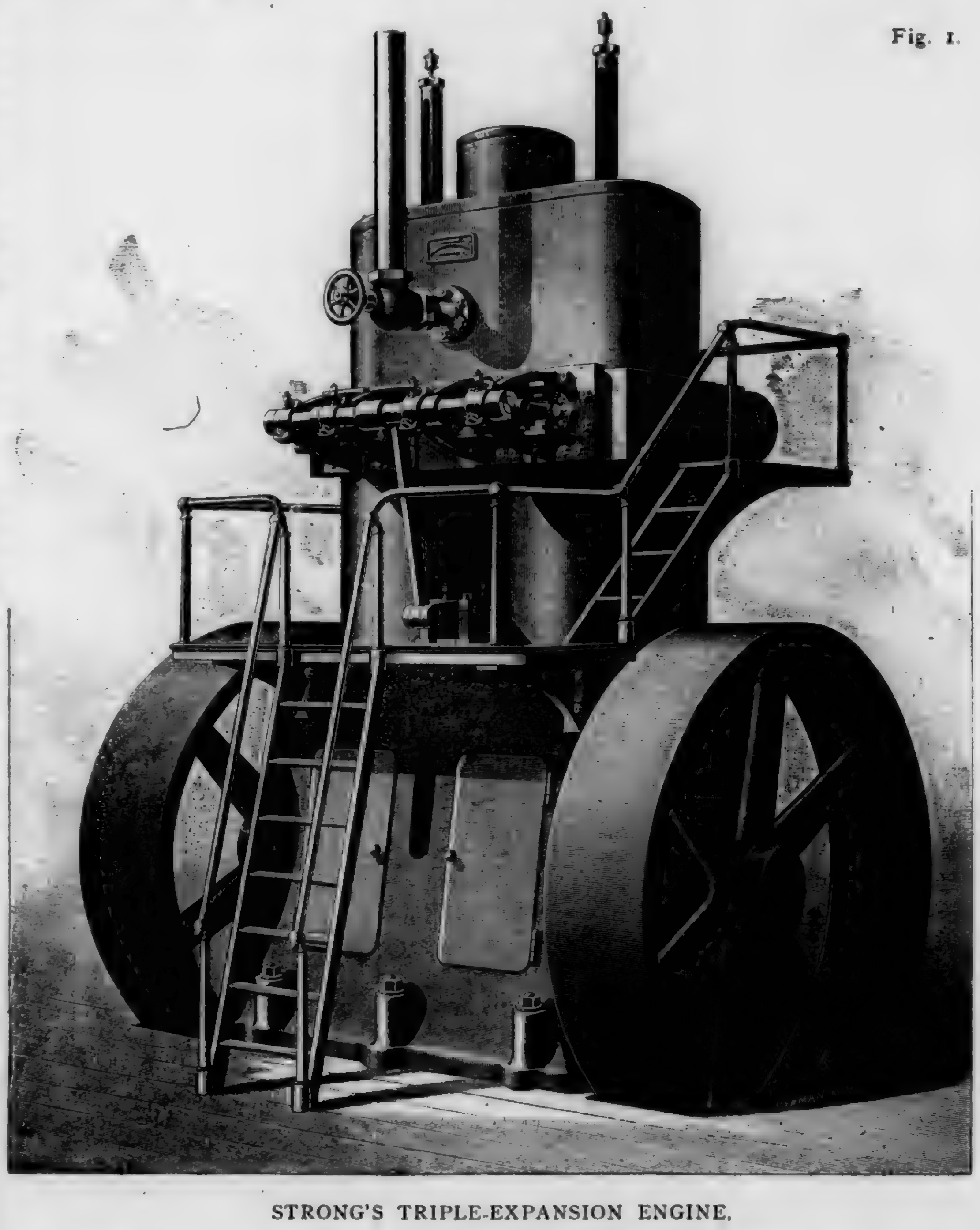
STRONG'S VERTICAL TRIPLE-EXPANSION ENGINE.

THE engine shown in the accompanying illustrations has been designed to meet the demand for a compact machine suitable for electric dynamo driving, and for other purposes where it is desirable to economize space, to secure economy in fuel, and to utilize the higher ranges of expansion, either as a condensing or non-condensing engine. There are many places where it is not practicable to use a condenser on account of the scarcity of condensing water, and as it is possible to secure about the same economy with very high steam pressure without condensation, this engine has been designed to fulfil that end. An effort has been made to put a triple-expansion engine into the simplest and most compact form, and at the same time to meet all the requirements that are considered necessary for general efficiency and economy. Fig. 1 is a perspective view of an engine of this class; figs. 2 and 3 are front and side views, showing the construction.

A peculiarity of the design is that the engine is self-contained and balanced. The reciprocating parts of the two sides have simultaneous opposite movements, the cranks being 180° apart, and thus in a manner balancing each other. In consequence of this, and of the fact that each side is independently balanced by a counterweight on the crank, less foundation is required, and more quiet running produced than would otherwise be the case. This is very important in buildings where jars from engines are very annoying. If it is desired that the engine shall be absolutely noiseless, it can be placed upon a foundation insulated on the bottom by cork from the foundations of the building, while on the sides packing or other material can be used that will transmit neither noise nor vibrations to the walls.

To meet the requirements of an engine using steam of 180 to 200 lbs. pressure, piston-valves have been selected for the high-pressure and intermediate cylinders, and gridiron slide valves for the low-pressure cylinders. By this means frictionless valves for the high and intermediate cylinders, where the pressure is high, are secured. In those cylinders the matter of clearance is comparatively unimportant. In the low-pressure cylinders, however, small clearances are very necessary for economy, and are brought about by the use of the gridiron valves in the cylinder-heads. As will be seen from the engravings, the high-pressure cylinder is placed over one of the low-pressure cylinders, and the intermediate cylinder over the other. The low-pressure cylinders take steam only on one side of the piston.

Fig. 1.



STRONG'S TRIPLE-EXPANSION ENGINE.

The piston-valve of the high-pressure cylinder is actuated by a block sliding in the well-known Fink link, so designed as to give a perfectly equal lap and lead, and at the same time equal cut-offs at both ends of the cylinder. The position of this block, and therefore the cut-off, is controlled by a sensitive high-speed governor, the resistance to the movement of which is very slight. The exhaust of the high-pressure cylinder, and the admission and exhaust of the intermediate cylinder, are controlled

by a connection to a fixed point at one end of the link. These valves have a fixed travel and point of cut-off. The movements of the low-pressure valves, both inlet and exhaust, are produced by the same connection to the Fink link, and are such that when these valves are unbalanced they are motionless.

All pins and bushings in the valve gear are of hardened steel, thus reducing the wear, and rendering replacement easy.

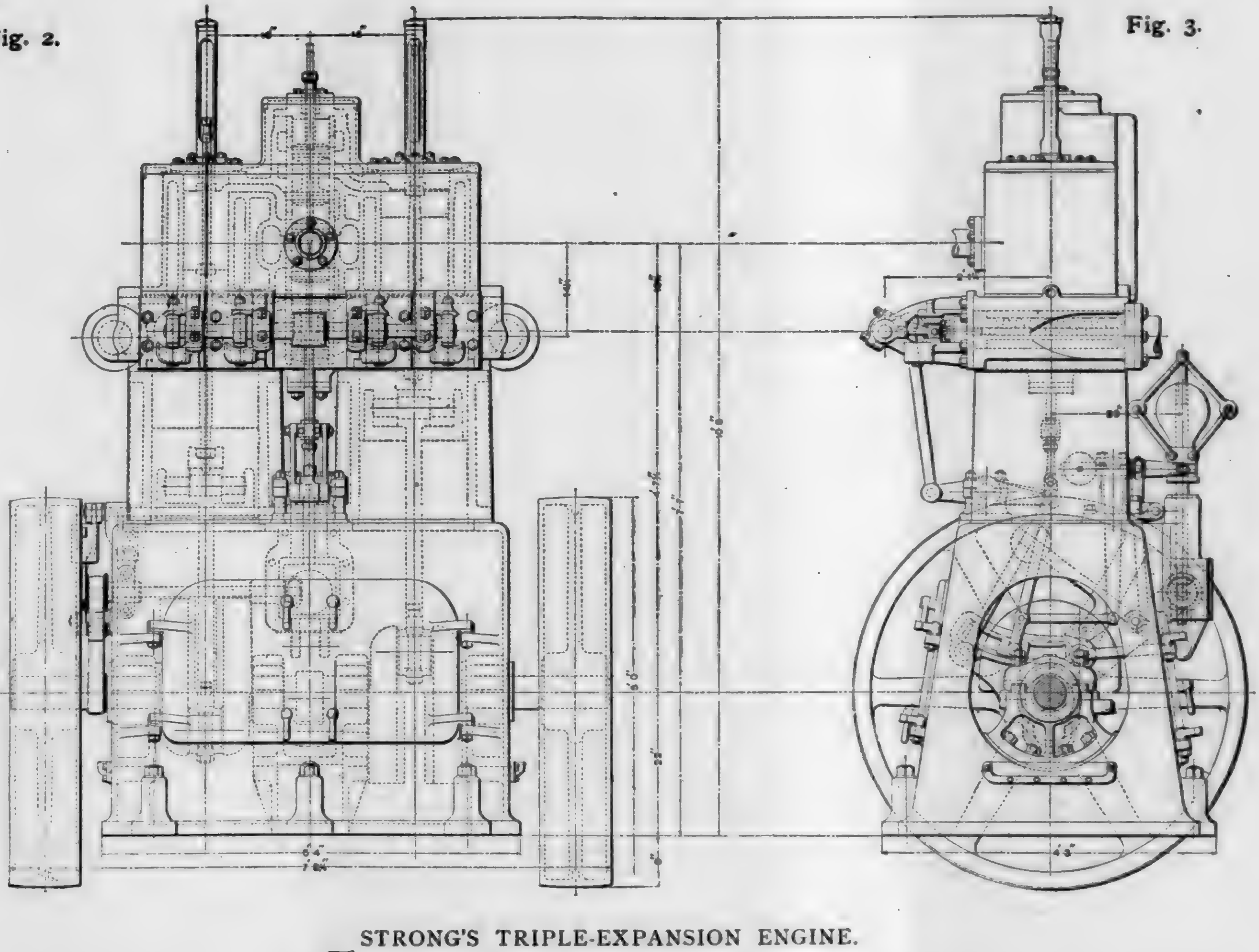
The governor is provided with a safety device, so arranged that in case the governor belt breaks, the arms of the governor will be elevated, and the link block thrown to an extreme position, thus cutting off the supply of steam and bringing the engine to a stop.

The crank shaft is forged from a solid steel ingot, and the counter-weight is bolted on. The pedestals are bored, and turned on their bases to fit a bored seat in the bed-plate or frame of the engine, to which they are secured by reamed bolts. The seats for these pedestals are bored by a single setting of a boring bar, and are consequently in perfect alignment.

Two sizes of this engine are shown in the accompanying illustrations, the one shown in perspective being of 150 indicated H.P., and the other, of which two views are given, of 250 indicated H.P. The first runs at a speed of 300 revolutions per minute, and the second at 225. It is the intention of the builders to manufacture these engines in sizes up to 2,500 H.P.

The engine described is the invention of George S. Strong, of 45 Broadway, New York, and is manufactured by the Providence Steam Engine Company, the builders of the well-known Greene automatic cut-off engine. This company believes that it is filling a long-felt need for an economical high-speed and high-class steam engine. The details of the engine have been worked out under the supervision of F. W. Dean, of Boston. With this engine a dynamo can be driven directly without the use of belts, the armatures taking the place of the fly-wheels shown in fig. 1. Its use is not by any means confined to electric work, however, but it is adapted to all purposes where a compact high-speed engine is required.

Fig. 2. Fig. 3.



STRONG'S TRIPLE-EXPANSION ENGINE.

THE FRICK COMPANY'S SHOPS.

As it is probable that some of our readers may not know the location of Waynesboro, it may be well to explain that it is located about 25 miles southwest of Gettysburg, of historic fame, in what is known as the Cumberland Valley, which lies between the Blue Ridge and Allegheny ranges of mountains. The valley is about 35 miles wide and is of marvellous fertility. Waynesboro is a place with about 4,000 or 5,000 inhabitants, and excepting for the two great industries carried on by the Frick and another company engaged in manufacturing agricultural machinery, it is almost as quiet as the residence of Rip Van Winkle.

The Frick Company are engaged chiefly in manufacturing steam-engines, saw-mills, and refrigerating machinery. From 600 to 800 men are employed, and they have facilities for turning out large quantities of work. Located as the works are near to supplies of coal, iron and wood, and in a region where living, and consequently labor, is cheap, the cost of manufacturing is correspondingly low. They are now engaged in making a great variety of engines, including portable, traction, or self-propelling portable, stationary slide-valve and Corliss engines. The portable engines are made in sizes the cylinders of which range from 4 to 12 in. diameter, the high-

LOCOMOTIVE RETURNS FOR THE MONTH OF JUNE, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	55	37,337	70,166	39,340	146,843	2,670	....	....	64.10	81.97	42.11	66.01	...	...	5.40	4.10	0.28	0.60	6.20	2.20	18.78	....	...	....
Alabama & Vicksburg	....	14	14,828	15,164	9,667	39,659	2,833	....	....	55.71	85.11	44.24	64.10	....	....	4.50	5.60	0.27	0.70	6.20	1.80	19.17	....	....	....
Atchison, Topeka & Santa Fé	834	739	....	....	375,046	2,133,790	2,887	....	....	...	....	....	79.62	....	....	5.05	6.01	0.30	0.12	6.61	1.36	19.45	....	...	1.38
Canadian Pacific	597	....	472,674	804,692	441,141	1,722,507	2,885	...	....	....	....	...	58.84	....	...	3.80	10.41	0.40	....	5.35	1.26	21.22	....	1.81	3.47
Chic., Burlington & Quincy	521	....	....	....	....	1,838,543	3,145	4.98	18.35	....	....	....	80.64	....	....	4.07	5.33	0.20	0.20	6.84	....	16.64	...	...	1.30
Chicago & Northwestern	869	....	694,715	1,404,009	847,956	2,946,680	3,391	....	....	...	....	....	78.86	....	.	3.23	7.39	0.37	....	6.34	0.79	18.12	....	...	1.85
Cincinnati Southern	....	101	78,174	172,482	85,131	335,787	3,325	....	..	61.92	102.04	42.19	78.13	....	....	4.20	4.80	0.26	0.70	6.40	1.60	17.96	....	...	...
Cleve., Cinn., Chic. & St. L.	....	426	444,845	576,429	371,467	1,392,741	3,269	4.70	21.90	70.25	106.50	64.90	84.00	14.94	4.86	3.23	5.33	0.21	2.47	6.39	0.23	17.86	....	....	1.26
Cumberland & Penn.	22	21	5,286	28,328	....	33,614	1,601	....	...	....	....	....	75.47	...	...	10.30	4.10	0.40	...	....	2.00	16.80	...	....	....
Delaware, Lackawanna & W. Main L.	208	201	....	....	....	679,532	3,380	....	....	..	....	....	85.11	....	....	3.27	7.02	0.42	....	5.95	....	16.66	....	....	....
Morris & Essex Division.	157	....	166,295	252,482	8,375	427,152	2,921	....	....	....	...	....	56.16	....	...	4.17	8.74	0.37	...	6.21	...	19.49	....	....	...
Hannibal & St. Joseph	...	78	....	....	....	259,185	3,322	5.11	17.25	...	....	....	75.05	12.76	6.03	5.13	4.78	0.17	0.20	....	6.65	16.95	....	....	1.30
Kan. City, F. S. & Mem.	146	....	98,471	206,538	108,438	413,441	2,832	....	....	...	....	....	54.60	....	...	3.31	4.58	0.14	0.40	7.28	....	15.71	....	....	1.62
Kan. City, Mem. & Birm.	41	38	35,985	48,624	17,853	102,462	2,499	....	....	...	...	....	52.07	....	....	2.07	3.06	0.24	0.42	7.05	....	13.74	....	....	1.12
Kan. City, St. Jo. & Council Bluffs	43	43	60,305	44,275	43,462	148,042	3,445	4.95	20.81	....	....	....	60.62	12.93	4.37	3.49	4.86	0.14	0.09	6.15	....	14.76	....	....	1.78
Lake Shore & Mich. Southern	588	560	430,105	667,103	575,152	1,672,860	2,987	....	....	55.80	81.36	31.34	58.25	....	....	3.27	4.58	0.16	....	6.90	0.22	15.13	....	....	1.57
Louisville & Nashville	....	*339	431,127	785,427	414,998	1,631,542	3,627	5.00	15.79	60.47	100.82	45.30	75.62	12.11	6.18	4.30	6.39	0.26	0.42	6.11	1.55	19.03	3.20	1.48	1.69
Manhattan Elevated	....	294	746,881	....	64,242	811,123	2,759	....	...	....	....	....	39.76	....	....	2.60	8.00	0.30	....	8.70	....	19.60	....	..	4.01
Mexican Central†	146	114	....	....	....	363,834	3,192	....	..	...	....	....	57.31	....	....	4.62	13.82	0.46	0.17	5.54	0.89	25.50	....	....	5.38
Mil., L. S. & Western	112	101	79,675	168,186	116,216	364,077	3,605	....	....	...	....	....	69.56	....	....	3.04	9.88	0.24	....	6.16	0.88	20.20	....	....	2.85
Minn., St. P. & Sault Ste. Marie	....	....	68,027	119,670	43,763	231,460	....	4.93	18.93	...	....	...	58.32	....	....	3.96	9.61	0.21	....	6.32	....	20.10	....	1.58	...
Missouri Pacific	339	299	....	....	....	1,089,075	3,642	4.50	17.37	....	....	....	79.55	15.62	5.67	5.44	5.55	0.32	1.39	6.48	1.39	20.57	4.00	1.42	1.37
N. O. & Northeastern	....	28	29,394	39,829	23,419	92,642	3,309	....	....	69.93	109.29	35.40	79.36	....	....	5.70	7.60	0.27	0.40	6.20	1.80	21.97	....	....	....
N. Y., Lake Erie & Western	....	621	450,007	937,928	291,212	1,679,147	2,704	4.70	22.90	81.50	119.90	64.50	...	17.40	5.20	5.02	6.42	0.40	1.69	7.13	1.12	21.78	...	1.55	1.28
N. Y., Pennsylvania & Ohio	....	259	136,983	431,406	142,628	711,017	2,748	5.60	17.90	72.00	118.30	68.40	....	12.90	6.60	3.66	5.76	0.31	2.00	6.83	1.00	19.56	....	1.64	1.15
Norfolk & Western, Gen. Eastern Div.‡	....	143	92,630	209,181	61,107	362,918	2,538	4.80	19.50	....	...	....	95.24	....	....	6.80	2.90	0.80	....	....	....	10.50	....	...	....
Durham Division‡	....	5	7,028	12,540	2,842	22,410	4,482	4.70	3.00	...	....	....	50.00	....	...	2.00	7.00	0.50	....	....	....	9.50	....	....	....
Radford Division‡	....	48	16,876	98,719	10,615	126,210	2,629	5.10	18.20	...	....	....	124.22	...	...	8.80	5.10	0.70	....	....	....	14.60	....	....	....
Pulaski Division‡	....	28	26,109	42,972	7,907	76,988	2,745	5.00	14.20	....	....	....	99.01	....	...	8.10	4.00	0.80	....	...	....	12.90	...	....	....
Clinch Valley Division‡	....	36	20,597	45,941	18,175	84,713	2,353	3.80	11.60	....	....	....	119.05	....	....	9.70	4.70	0.90	....	...	....	15.30	...	....	....
Winston-Salem Division‡	....	10	15,669	10,611	3,354	29,634	2,963	2.30	8.50	....	....	....	68.96	....	....	2.10	6.20	2.20	....	....	....	10.50	....	....	...
Old Colony	....	230	347,264	141,503	124,656	613,423	2,667	...	....	....	....	....	54.29	....	....	3.15	10.18	0.63	....	6.65	0.78	21.39	....	....	3.75
Philadelphia & Reading	....	....	459,790	731,330	530,959	1,722,079	....	....	....	....	....	....	76.77	....	....	4.44	4.31	0.32	...	5.72	0.41	15.20	...	....	....
South. Pacific, Pacific System	705	....	....	....	....	1,698,554	2,409	....	....	....	....	....	67.61	....	...	5.25	18.42	0.37	1.67	7.32	1.71	34.74	...	...	5.56
Union Pacific	995	....	712,837	1,407,852	455,304	2,575,993	2,589	5.59	16.80	....	....	....	90.09	13.99	6.97	6.86	8.56	0.43	0.80	7.92	1.06	25.63	4.28	1.85	1.98
Vicksburg, S. & P.	....	15	11,314	9,729	11,390	32,433	2,162	....	....	51.02	82.64	30.53	51.68	...	....	2.90	7.10	0.22	1.20	6.70	2.30	20.42	....	....	....
Wabash	400	339	398,440	625,814	243,426	1,267,680	3,739	5.04	17.12	64.96	99.43	52.05	76.95	12.89	5.54	2.98	4.50	0.26	....	6.24	0.89	14.87	2.51	0.99	1.16
Wisconsin Central	152	126	134,027	211,415	79,525	424,967	3,373	....	....	...	....	....	73.37	....	....	3.15	9.42	0.23	....	7.23	....	20.03	....	....	2.50
Year ending June 30.																									
Atchison, Topeka & Santa Fé	834	718	....	....	4,079,383	24,931,357	34,723	....	....	..	..	..	80.87	....	....	5.16	6.79	0.29	0.15	6.58	1.52	20.49	....	....	1.63
Kansas City, Ft. Scott & Memphis	....	145	1,172,247	2,669,783	1,325,961	5,167,991	35,646	....	....	....	....	....	61.46	....	....	3.59	5.33	0.25	0.51	7.24	....	15.92	....	....	1.68
Kan. City, Mem. & Birm.	41	41	428,723	679,699	156,873	1,265,295	30,885	....	....	....	....	....	64.04	....	....	3.11	3.62	0.29	0.43	7.05	...	14.50	....	....	1.09
Old Colony	....	218	3,989,836	1,536,438	1,449,032	6,975,306	31,997	....	....	....	....	....	57.54	....	....	3.24	11.16	0.62	....	6.75	0.80	22.57	....	....	3.88
Wabash	400	349	4,825,838	8,307,110	3,071,882	16,204,830	46,432	5.00	17.72	[illegible].20	102.20	53.94	82.43	13.32	5.76	3.11	4.77	0.29	....	6.23	0.86	15.26	2.66	0.98	1.16

Note.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 18.5 units of work per $1 of expense; 184.1 units of work per ton of coal; 10.86 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

speed engines from 5 to 14 in., and the Corliss machines from 10 in. up to anything. Thus far the largest size made has been 44 in.

The traction engines are provided with wrought-iron channel-bar frames, one on each side of the fire-box running parallel with it. In front of the fire-box they are curved inward, until they almost join, and are bolted to each other, and extend to the front axle saddle-block, to which they are riveted, the front end of the boiler resting upon the saddle-block. These channel-bars form the foundation of the whole system. They are rigidly connected to the boiler at only one point in their length, expansion pieces being bolted to the boiler, in front of and behind the rigid connection, which, while engaging the upper part of the saddle and preventing side-play, allow for expansion and contraction of the boiler by permitting of end-play. The channel-bars back of the fire-box are connected with each other by cross-plates. The fire-boxes have water bottoms, and a belly girth or band is riveted to the channel-bars and passes under the fire-box, thus supporting the boiler. In order that the under side of the fire-box may have a perfect bearing on this belly-band, soft melted metal is poured into the space between the two. The boiler is thus supported on the belly-band and on the front saddle. To support the engine and gearing, and keep the straining action of the working parts from affecting the boiler, strong vertical side-plates are riveted to the channel-bar frames on each side of the fire-box. These support the axle and crank-shaft bearings, and extend upward so as to receive the crank end of the engine bed-plate. This is in the form of an arch extending from one plate to the other and over the top of the boiler. The front end of the engine bed-plate simply rests on the boiler on a freely sliding expansion joint. The channel-bars thus form a complete frame, which rests on the main driving and front wheels; the vertical side plates being raised high enough to carry the engine, which is located above the boiler, and is bolted to these plates.

If the driving power of an engine is transmitted through the rigid connection of a train of gearing to the main axle there is great liability to break. For this reason an elastic compensating gear has been devised and patented, and is used by the Frick Company, for driving their machines. The construction of this could not be explained so as to be clearly understood without the aid of an engraving. It must suffice, therefore, to say that the power of the engine is transmitted to the wheels through the medium of spiral springs, which effectually cushion all sudden shocks and insures smoothness of action.

The valve-gear consists of a loose eccentric, which can be shifted on the axle. An engraving would, however, be required to explain the mechanism by which this is effected.

A great variety of forms of portable engines are made; some of them are self-propelling and some are not, some are mounted on wheels, and others have only a wooden frame which facilitates their removal from one place to another. The same engines are made with frames intended to be stationary.

The line of high-speed, automatic cut-off engines, as already remarked, includes sizes varying from 5 to 14 in. in the diameter of the cylinders. These have Professor John E. Sweet's balanced slide-valve, which is controlled by a "regulator," which is secured to the crank-shaft of the engine, and all the mechanism is contained within a small driving pulley. The parts consist of two pivoted levers, provided with weights; these are connected to each other and to an adjustable counterbalanced shifting eccentric by links. The eccentric is so arranged that it adjusts the movement of the balanced slide-valve in the steam-chest, and controls the distribution of steam to the piston from zero to nearly full stroke. The maximum number of revolutions at which the smaller sizes of these engines will run is 337 and the larger sizes 240.

The plain slide-valve engines have Corliss girder bed-plates with the steam-chests on the sides of the cylinders, the valves being connected directly to the eccentrics. Besides these engines the Company makes upright engines adapted for rolling-mills and grain-elevators. These are made either with the ordinary slide-valve or with Professor Sweet's valve and an automatic regulator or with the Corliss valve-gear.

Mr. Edgar Penney, the Mechanical Engineer and General Superintendent of the Frick Company, occupied for some years an important position with the Corliss Steam Engine Company of Providence, R. I., and in that connection had large experience in designing, testing, and experimenting upon all types of Corliss engines, an opportunity presented to but few in the business. The Frick Company, therefore, claim that they are making the genuine, standard Corliss engine, as finally developed and improved by Mr. Corliss. These engines are made with horizontal and vertical cylinders and frames, compound and non-compound, and condensing or non-condensing.

Compound engines are made of the "tandem" type or with the cylinders side by side, and connected to cranks at right angles to each other on opposite ends of the main shaft.

It would be impossible to give any satisfactory account of the refrigerating and ice-making machinery manufactured by the Frick Company without occupying more space than is available here. There was an 85-ton machine nearly completed in the shop at the time of our visit, intended for the Moore Packing Company. Three other 200-ton machines have just been shipped to the Armour Packing Company, of Chicago, and two 100-ton machines to the Union Stock Yards at San Francisco. All these had compound engines. The Frick Company have patterns for machines with a capacity of 200 tons of ice per day, but would build them of 600 tons if required. The Company publishes a very excellent book on this kind of machinery, in which the theory and practice of refrigeration is very fully explained.

The machine tool shop is 300 × 60 ft.; this is the original shop. A new erecting shop 260 × 30 ft. with an annex 80 × 50 ft. has just been completed. This shop is provided with a 15-ton traveling crane with two speeds on hoist and two on bridge. This crane was built by this Company in its own shops. Besides this there are three jib cranes driven by power for handling work. The grinding shop is in a basement, but is not yet equipped with its machinery.

The main erecting shop for heavy machinery is 45 ft. wide × 45 ft. high × 315 ft. long. A 25-ton traveling crane is employed in this shop for handling work. In one end of this shop a pit lathe, which will turn 40 ft. diameter and 10 ft. face, is provided for finishing large fly-wheels, pulleys, and other work. It is of very simple construction, but apparently very efficient.

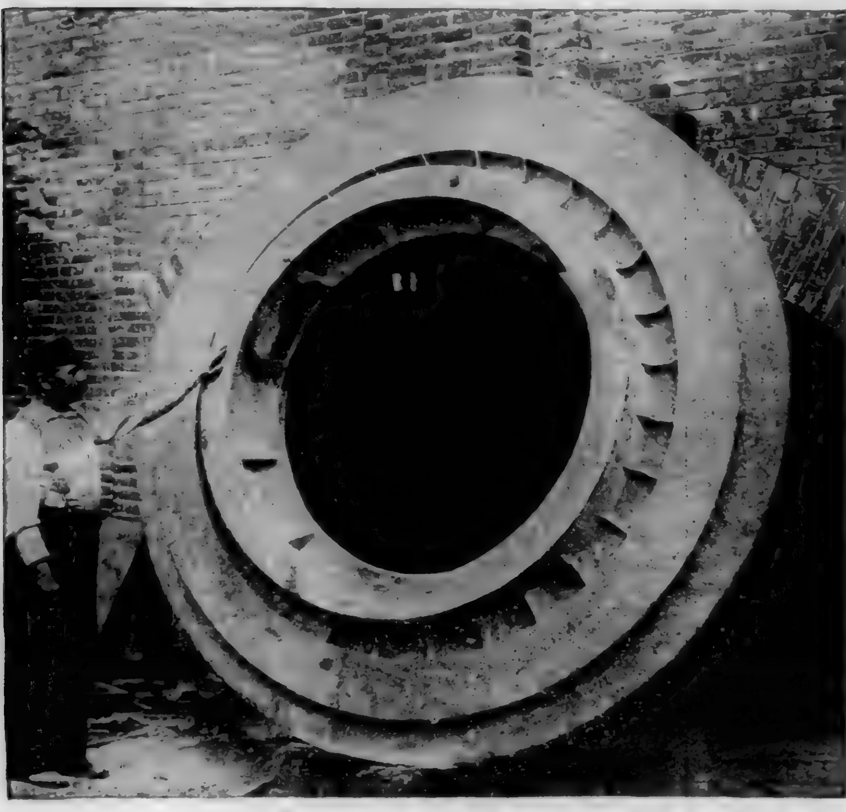
The shops are driven by three engines, one of 200 H.P. and the other two of 75 H.P. each; 450 incandescent and 30 arc lights are used for illumination. The foundry is 100 × 150 ft. with five jib cranes, and a new 25-ton traveling crane is now being erected. It is proposed to build a new foundry 120 × 400 ft. in the near future. The blacksmith shop is 125 × 50 ft., and is provided with three Bement steam hammers, and a scrap furnace in which all their own scrap is worked up. The heat from this furnace is conducted to a vertical boiler which supplies steam to the hammers, and is also connected with the general system of steam-pipes in the shop.

The boiler shop is 100 × 123 ft. All riveting is done by hand. The caulking is done with the tools of the Pneumatic Tool Company. The tubes are also beaded with this same machine. All the pipes used in refrigerating machinery are tested under water in this shop with air pressure. Any leak is thus detected at once. The connections are made of tapered screw joints, which are cut with great care so as to insure accuracy. Before being screwed together they are cleaned with benzine and are then painted with a mixture of glycerine and litharge, which forms a satisfactory cement. Flange joints are made with a ring of soft lead which is held in grooves turned in the flanges.

The wood-working shop is 100 × 125 ft. The saw-mills made by this Company would require more room to describe than is available here. Altogether the shops are very well arranged and equipped, and the Company has been wise enough to publish a number of excellent descriptive pamphlets describing their products which can be obtained by any one interested therein.

A Remarkable Steel Casting.

THE accompanying engraving is from a photograph of a very remarkable steel casting recently made by the Midvale Steel Company in Philadelphia. This casting is for the roller path for the 8-in. disappearing gun carriage built by the Ordnance Department of the United States Army ; it is notable not only on account of its great size and weight—7,995 lbs. shipped—but also for the high grade of metal used.



A REMARKABLE STEEL CASTING.

The specifications of the Ordnance Department, under which this casting was made, called for a tensile strength of 65,000 lbs. per square inch, with an elongation of 20 per cent.; the minimum allowed was 55,000 lbs. tensile strength and 15 per cent. elongation.

The official test of the casting, on a test-bar 0.505 in. diameter and 2 in. long between measuring points, showed the following results : Tensile strength, 73,000 lbs. per square inch ; elastic limit, 35,500 lbs.; elongation, 33.20 per cent.; contraction, 47.18 per cent.

It is especially to be noted that the test showed an elongation 66 per cent. above that required by the specification, and 120 per cent. above the minimum allowed.

Foreign Naval Notes.

A DUTCH COAST-DEFENSE SHIP.

THE accompanying illustrations, from *Industries*, show the coast-defense ship *Reinier Cleassen*, recently launched from the navy yard at Amsterdam, Holland. She will be ready for service during the present year. Her principal dimensions are : Length between perpendiculars, 217 ft. ; length over all, 230 ft. ; breadth, 44 ft. 4 in. ; molded depth, 16 ft. 7 in. ; with a displacement of 2,490 tons on a mean draft of 14 ft. 5 in. The fore and aft parts of the vessel have comparatively little freeboard—only about that given to a monitor—but for a part of her length it is greater. All the vital portions are protected by a steel deck and a belt of compound armor plates, both running the whole length. The deck in the middle is 1 ft. 2 in. above and at the sides, 3 ft. 7 in. beneath the load water line. The compound plates, made by John Brown, of Sheffield, are 4¾ in. thick over a length of 95 ft., and fore and aft 4 in. thick, with a teak backing of about 6 in. The vessel is provided with a double bottom extending over a length of 120 ft., and between the upper and protective decks a cellular construction has been adopted, the outer cells being filled with cellulose. Seven transverse bulkheads divide the hull into water-tight compartments, and a longitudinal bulkhead divides the engine and boiler rooms. Steel has been exclusively adopted in the construction, the stem and stern ports, rudder frame and supports of the screw shafts being cast.

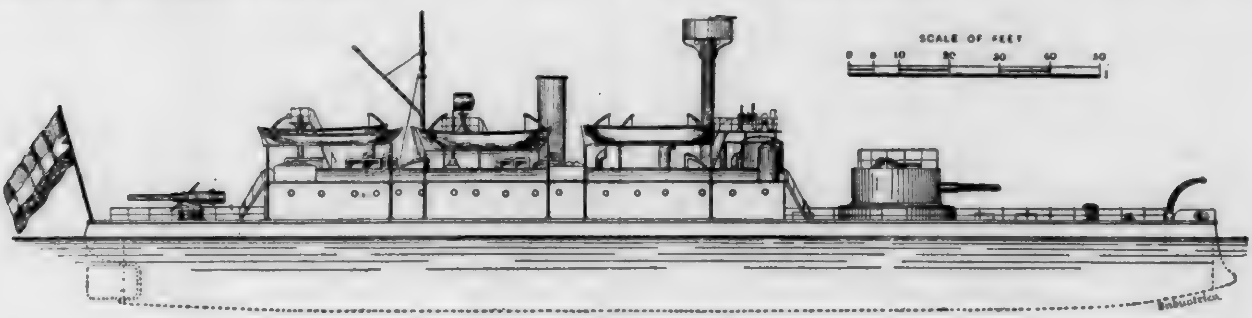


FIG 1.—GENERAL ELEVATION OF VESSEL

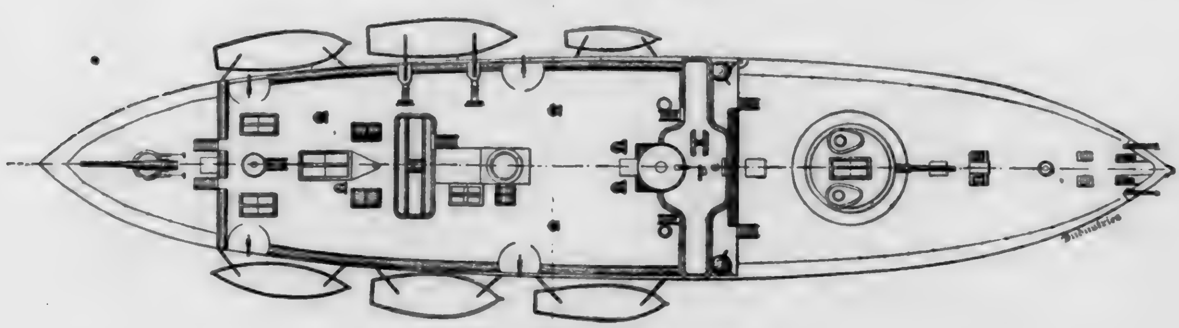
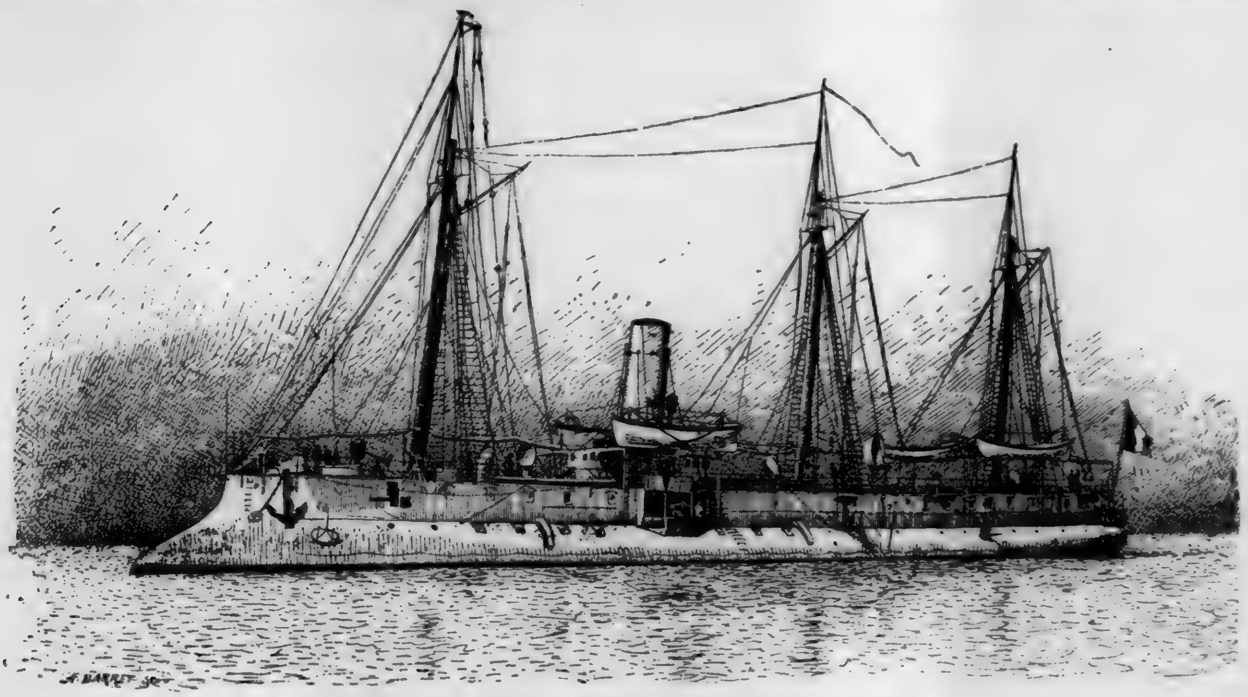


FIG 2.—GENERAL PLAN

COAST-DEFENSE SHIP FOR THE DUTCH NAVY.

The armament consists of two Krupp guns, one 8¼ in. and one 6¾ in., both 35 calibres long ; four quick-firing Krupp guns of 2 in. on the bridge deck, and two quick-firing 1½ in. guns



TORPEDO GUNBOAT "WATTIGNIES," FRENCH NAVY.

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The twin-screw propellers are driven by vertical triple-expansion engines, having cylinders 20 in., 30 in., and 50 in. diameter respectively, with a stroke of 19 in. They are to be capable of developing 2,400 H.P. at 190 revolutions, and with steam of 170 lbs. pressure. The condensers are cylindrical, with a cooling surface of 3,800 sq. ft.; the centrifugal circulating pumps, delivering 360 tons of water per hour, are independent of the main engines, and may also be used as bilge pumps. The crank and propeller shafts are of steel, and the propeller blades of Delta metal. The propellers are four-bladed, and are 8½ ft. diameter, with a pitch variable between 8 ft. and 10 ft. The boilers—three in number—are single-ended, and of steel, each having two Purves' flues. The boilers are 17 ft. long, with a diameter of 8½ ft., and are intended for forced draft. The engines and boilers are being constructed by the Royal Schelde Company, of Flushing.

A SUBMARINE BOAT.

THE accompanying illustrations, figs. 2, 3 and 4, represent diagrammatic sections of a novel form of submarine vessel recently launched from the yard of Messrs. Migliardi & Vene, of Savona, Italy, which has been designed by Messrs. Pietro degli Abbati & Sons, and which is being introduced by a company entitled the Società Romana per la Pesca e Ricupero dei Valori Subacquei. The vessel, which is of steel, is 28 ft. long, 6½ ft. broad, and 9⅔ ft. deep, and is provided with a screw propeller actuated by an electromotor. Referring to fig. 2, *B* is the manhole through which the crew, consisting of five men, enter the vessel, and *S* are the port-holes fitted with strong glasses. On the left-hand side of the hull near the stern a door is provided which may be opened from the inside when under water for allowing exit to divers, without admitting water into the vessel. The hull is provided with three water-tight compartments, and it is estimated that the crew will be able to remain under water for a period of 48 hours.—*Industries.*

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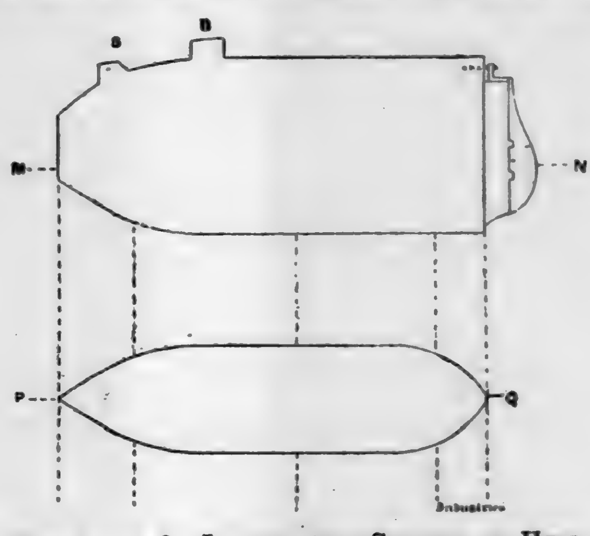
The twin screws are driven by two engines, which on the last trial worked up to 4,200 H.P., giving the ship an average speed of 18.6 knots an hour. There are four tubular boilers, each with two furnaces. The coal bunkers hold 160 tons, which



FIGS. 2 AND 3.—LONGITUDINAL SECTIONS OF HULL.

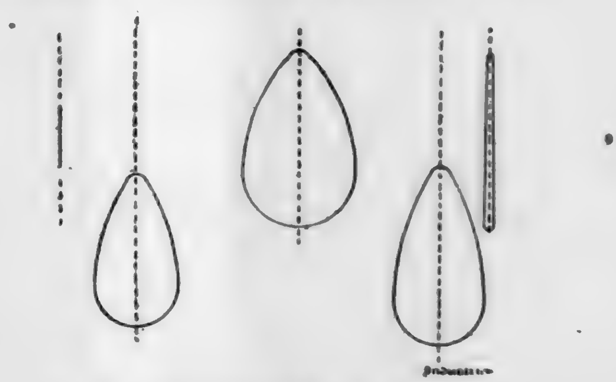


FIG. 4.—TRANSVERSE SECTIONS OF HULL.

is sufficient for 552 knots at full speed, or for 1800 knots at a 12-knot rate.

The general dimensions are: Length, 229.6 ft.; breadth, 29.2 ft.; draft forward, 11.4 ft.; draft aft, 15.4 ft.; displacement, 1,306 tons.

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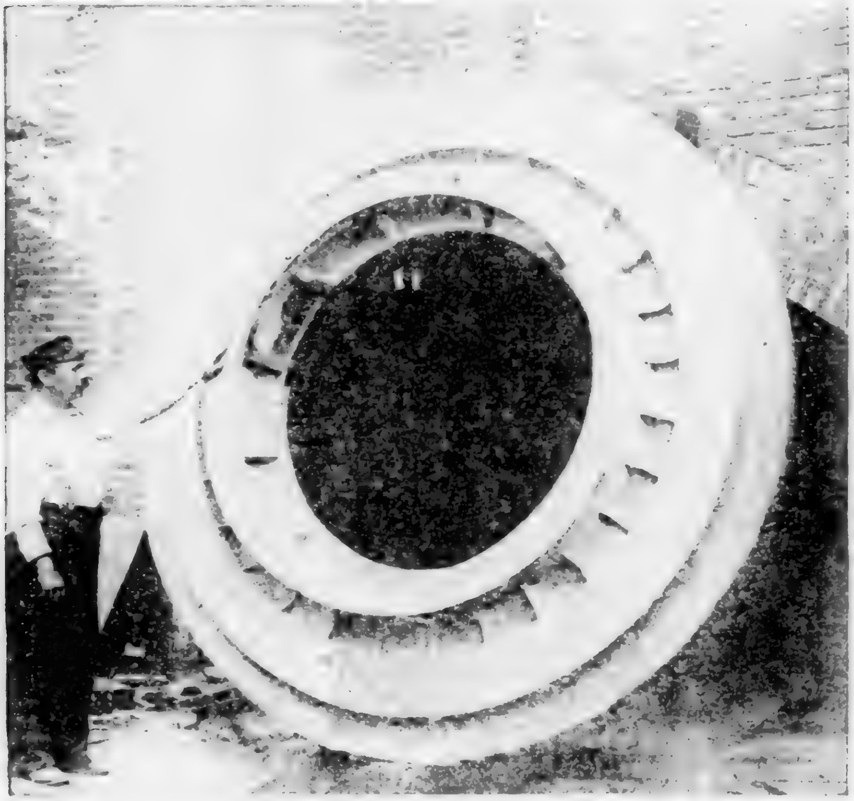

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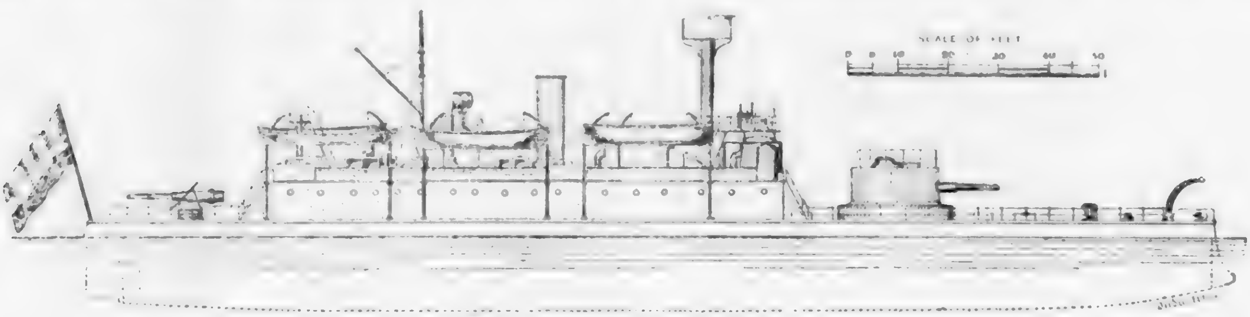

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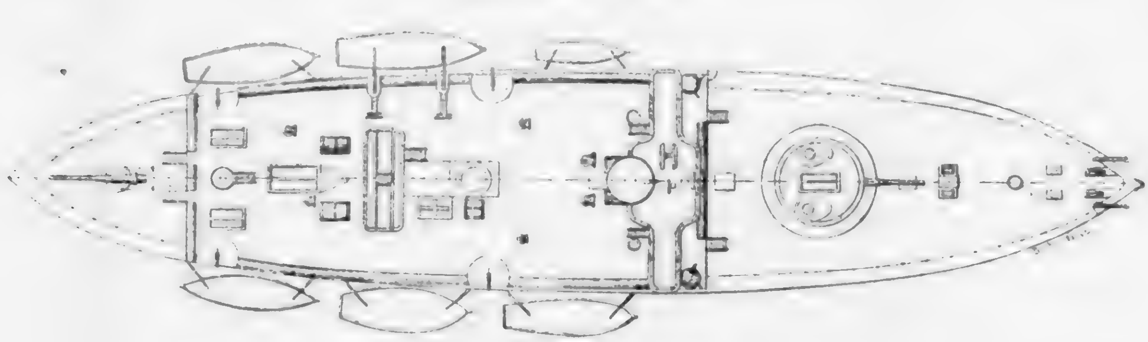

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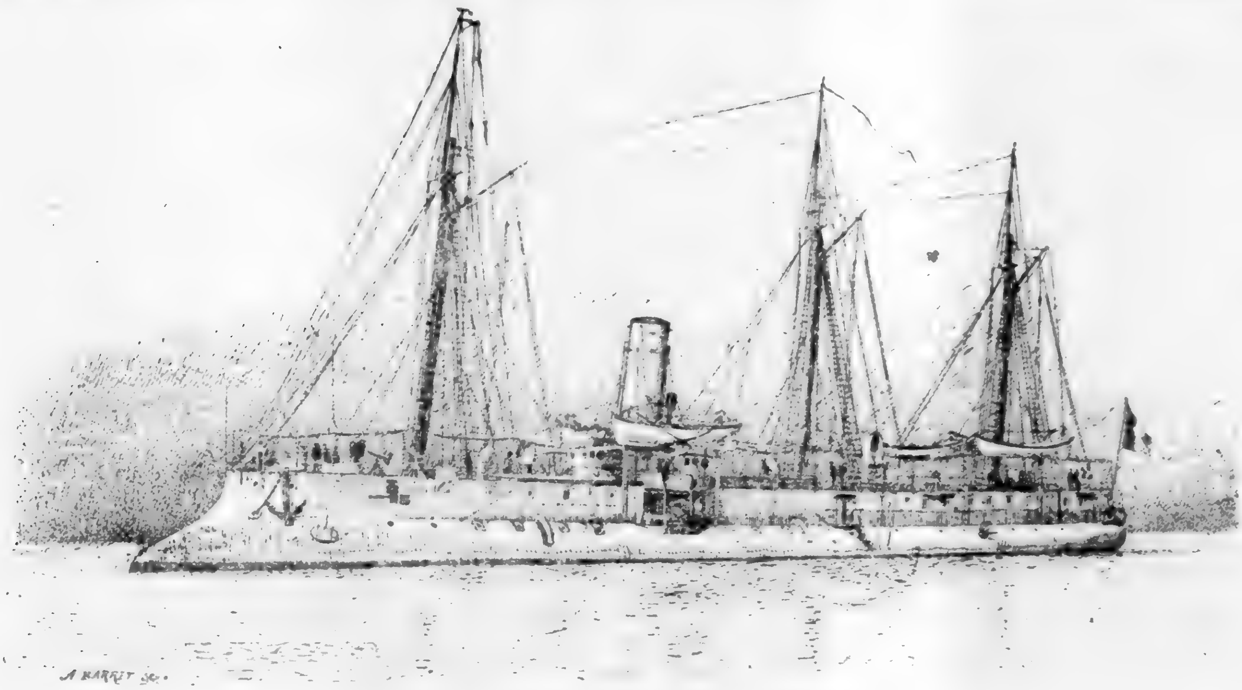

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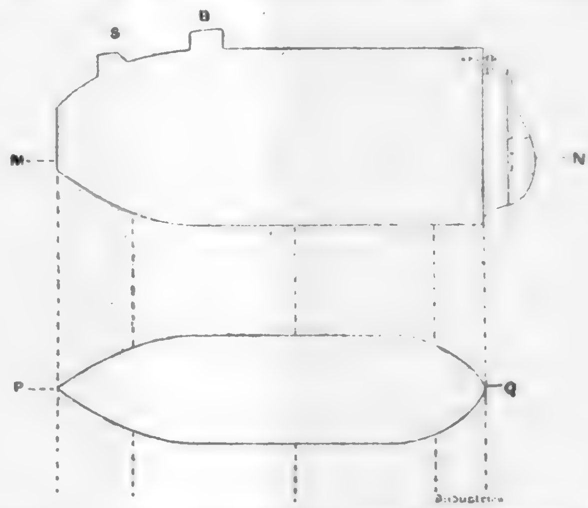

Figs. 2 and 3.—Longitudinal Sections of Hull.

Fig. 4.—Transverse Sections of Hull.

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The general dimensions are: Length, 229.6 ft.; breadth, 29.2 ft.; draft forward, 11.4 ft.; draft aft, 15.4 ft.; displacement, 1,306 tons.

There are four torpedo-tubes, two forward and two aft. The other armament includes five 10-cm. (3.93-in.) rapid-fire guns; two 65-mm. (2.56-in.) rapid-fire guns and four 37-mm. (1.46-in.) revolving cannon.

The *Wattignies* has cost in all about $580,000. She has the long ram bow and narrow deck which mark nearly all the French cruisers.

A Large Ship's Rigging.

THE illustration given herewith is from a photograph of part of the standing rigging of the American built ship *Shenandoah*, one of the largest wooden vessels ever built. The *Shenandoah* was built in the Sewall yard at Bath, Me., and was of nearly the same dimensions as the *Roanoke*, recently launched, of which an account is given elsewhere.

STANDING RIGGING OF THE SAILING SHIP "SHENANDOAH."

To any one familiar with sailing-vessels, the photograph will show how great a change has been made in their rigging, the iron turnbuckles and connections taking the place of the old-time rope gaskets. Of course a very high quality of work is required, since the ship's safety is largely dependent on the excellence and holding power of the rigging, and the strain put upon it with a large ship and a high wind is sometimes very great. It is, moreover, a variable strain, the amount of which it is very difficult to calculate.

It may be added that the turnbuckles used on the *Shenandoah's* rigging were made by the Cleveland City Forge & Iron Company, and are of pressed wrought iron.

Manufactures.

Baltimore Notes.

THE Potomac Valley Branch of the Western Maryland Railroad was opened to passenger traffic September 12, and the train service between Baltimore and Hagerstown was extended to Cherry Run, W. Va., where it connects with the Baltimore & Ohio main line. The road consists of 14.3 miles of main track, with 2 miles of sidings; it is substantially built; all bridges are of iron, supported upon first-class masonry, and heavy steel rails and stone ballast have been used throughout. The bridge over the Potomac River, with its trestle approaches, and the iron span over the Chesapeake & Ohio Canal, represent a cost of about $100,000, or nearly one-fourth of the cost of the entire road. The bridge proper consists of five spans of 140 ft. each, and is elevated to admit of a rise in the river of 45 ft. above low-water mark. The opening of this line will give the Western Maryland a 66-mile line between the Philadelphia & Reading at Shippensburg, Pa., and the Baltimore & Ohio at Cherry Run, W. Va.

THE project of establishing a line of freight steamers between Baltimore and Wilmington, N. C., and Charleston, S. C., is assuming shape. Shipping men in Baltimore are interesting themselves in the matter, and plans for the organization of the proposed company have been prepared by Mr. James B. Andrews. The only line running out of Baltimore to Southern ports is the one to Savannah, and the large business handled by this company should furnish an object lesson of the possibilities at other coast towns with suitable transportation facilities. By the plan now under contemplation it is proposed to establish a line of first-class steamers to run semi-weekly between Baltimore and Wilmington and Charleston. For this service three boats will be necessary. The steamers are to be not less than 1,500 tons each. They are to be built of steel or iron, furnished with all modern appliances for handling cargo and anchors by steam, and are to have a speed of not less than 12 miles an hour. It is estimated that such steamers as contemplated will cost $150,000 each. The company to operate the line and build the boats is to be organized with a large capital stock. The steamers are to be constructed expressly for freight boats, with no passenger accommodations. The money that would be applied to passenger accommodations, which are usually costly, is to be expended in perfecting every practical modern working device that will tend to improve the steamers and enhance the trade in which they will engage and in cheapening the cost of labor in handling freight.

THE directors of the City Passenger Railroad Company have awarded a contract for 62 grip and trail cars for the Red, White, and Blue cable lines to the J. G. Brill Company. The grip cars will be constructed with the grips in the middle instead of at the ends. This will enable a car to be run in opposite directions without the use of a loop at the terminus of the line, or without turning the car, as it is intended to construct the cable lines of the City Passenger Railroad Company without loops. The cars will be similar to those in use in Washington.

THE South Baltimore Car Works have completed 650 Lumber Line box cars for the Baltimore & Ohio, and they are now working on a lot of 350 of the same kind of cars for the West Virginia & Pittsburgh. These cars have automatic couplers, full height end doors, and are designed for the lumber trade in West Virginia.

THE Baltimore & Ohio is having some additional refrigerator cars thoroughly repaired and rebuilt at the South Baltimore Car Works.

THE Baltimore & Ohio Southwestern contemplates building some coal cars, but the contract has not yet been received.

Boiler Pitting Cured by Graphite and Oil.

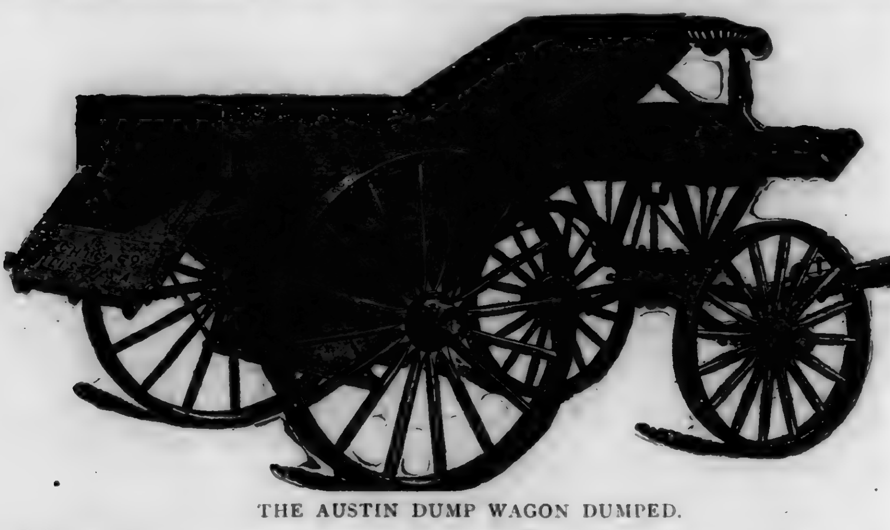
IN the *American Machinist* of July 28, Mr. T. T. Parker has a very interesting article regarding pitting in boilers. Besides some theories, he has this to say from a practical point of view: "In a boiler of the porcupine persuasion pitting was found in the mud drum. Acting under advice, the drum was cleaned and scraped, after which it was painted with graphite mixed with cylinder oil. Measurements of the depths of the pits were taken, and six months after they were found no deeper, and no new ones had shown up. Other parties have since tried this

experiment in mud drums, but it is too early as yet to give the result. However, knowing the character of plumbago, if the interior of a boiler could be painted with it in such a way that it would stay it may be this would prove a remedy. I am satisfied also that the person doing so would kill two birds with one stone, as the scale could be easily detached. In a pair of cylindrical boilers 42 × 28 occasional applications of cylinder oil (mineral) and plumbago have kept back corrosion on a trial of six months. Boilers were new when plumbago was used. The boilers which the new ones replaced were thrown out rotten from corrosion. The feed was mine water, as nothing else could be had. '

In addition to Mr. Parker's remarks we add that Harig, Koop & Company, Louisville, Ky., after experiencing more or less trouble from rust and scale in the mud drums of their boilers, applied with great success graphited oil, purchased from the Joseph Dixon Crucible Company, Jersey City. The mud drums were cleaned out and the graphited oil applied with swab, brush, or anything handy, to the joints and parts where the water enters the drums. Every four or six weeks this process is repeated with the most gratifying results.

The Austin Dump Wagon.

THE dump wagon is not so generally employed as its usefulness deserves, due probably to the fact that until now a satisfactory dump wagon has not been produced. The accompanying picture illustrates a dump wagon manufactured by the



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Lake Ship Building.

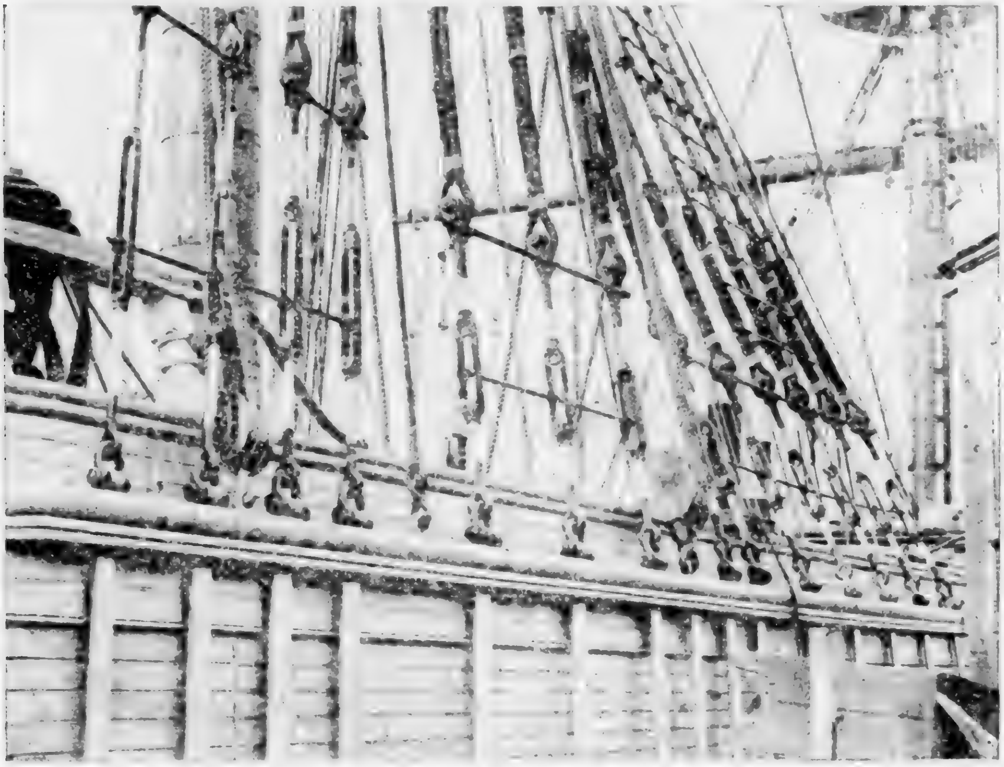
THE Globe Iron Works Company, Cleveland, O., has just completed the steel steamer *Mariposa* for the Minnesota Steamship Company. The general dimensions of the *Mariposa* are 353 ft. over all, 335 ft. keel, 45 ft. beam and 24 ft. 6 in. molded depth. Her estimated carrying capacity is 4,000 tons on a draft

There are four torpedo tubes, two forward and two aft. The other armament includes five 10 cm. (3.93-in.) rapid fire guns; two 65 mm. (2.56-in.) rapid-fire guns and four 37-mm. (1.46-in.) revolving cannon.

The *Wattignies* has cost in all about $580,000. She has the long ram bow and narrow deck which mark nearly all the French cruisers.

A Large Ship's Rigging.

The illustration given herewith is from a photograph of part of the standing rigging of the American built ship *Shenandoah*, one of the largest wooden vessels ever built. The *Shenandoah* was built in the Sewall yard at Bath, Me., and was of nearly the same dimensions as the *Roanoke*, recently launched, of which an account is given elsewhere.



STANDING RIGGING OF THE SAILING SHIP "SHENANDOAH."

To any one familiar with sailing-vessels, the photograph will show how great a change has been made in their rigging, the iron turnbuckles and connections taking the place of the old-time rope gaskets. Of course a very high quality of work is required, since the ship's safety is largely dependent on the excellence and holding power of the rigging, and the strain put upon it with a large ship and a high wind is sometimes very great. It is, moreover, a variable strain, the amount of which it is very difficult to calculate.

It may be added that the turnbuckles used on the *Shenandoah's* rigging were made by the Cleveland City Forge & Iron Company, and are of pressed wrought iron.

Manufactures.

Baltimore Notes.

The Potomac Valley Branch of the Western Maryland Railroad was opened to passenger traffic September 12, and the train service between Baltimore and Hagerstown was extended to Cherry Run, W. Va., where it connects with the Baltimore & Ohio main line. The road consists of 14.3 miles of main track, with 2 miles of sidings; it is substantially built; all bridges are of iron, supported upon first-class masonry, and heavy steel rails and stone ballast have been used throughout. The bridge over the Potomac River, with its trestle approaches, and the iron span over the Chesapeake & Ohio Canal, represent a cost of about $100,000, or nearly one-fourth of the cost of the entire road. The bridge proper consists of five spans of 140 ft. each, and is elevated to admit of a rise in the river of 45 ft. above low-water mark. The opening of this line will give the Western Maryland a 66-mile line between the Philadelphia & Reading at Shippensburg, Pa., and the Baltimore & Ohio at Cherry Run, W. Va.

The project of establishing a line of freight steamers between Baltimore and Wilmington, N. C., and Charleston, S. C., is assuming shape. Shipping men in Baltimore are interesting themselves in the matter, and plans for the organization of the proposed company have been prepared by Mr. James B. Andrews. The only line running out of Baltimore to Southern ports is the one to Savannah, and the large business handled by this company should furnish an object lesson of the possibilities at other coast towns with suitable transportation facilities. By the plan now under contemplation it is proposed to establish a line of first-class steamers to run semi-weekly between Baltimore and Wilmington and Charleston. For this service three boats will be necessary. The steamers are to be not less than 1,500 tons each. They are to be built of steel or iron, furnished with all modern appliances for handling cargo and anchors by steam, and are to have a speed of not less than 12 miles an hour. It is estimated that such steamers as contemplated will cost $150,000 each. The company to operate the line and build the boats is to be organized with a large capital stock. The steamers are to be constructed expressly for freight boats, with no passenger accommodations. The money that would be applied to passenger accommodations, which are usually costly, is to be expended in perfecting every practical modern working device that will tend to improve the steamers and enhance the trade in which they will engage and in cheapening the cost of labor in handling freight.

The directors of the City Passenger Railroad Company have awarded a contract for 62 grip and trail cars for the Red, White, and Blue cable lines to the J. G. Brill Company. The grip cars will be constructed with the grips in the middle instead of at the ends. This will enable a car to be run in opposite directions without the use of a loop at the terminus of the line, or without turning the car, as it is intended to construct the cable lines of the City Passenger Railroad Company without loops. The cars will be similar to those in use in Washington.

The South Baltimore Car Works have completed 650 Lumber Line box cars for the Baltimore & Ohio, and they are now working on a lot of 350 of the same kind of cars for the West Virginia & Pittsburgh. These cars have automatic couplers, full height end doors, and are designed for the lumber trade in West Virginia.

The Baltimore & Ohio is having some additional refrigerator cars thoroughly repaired and rebuilt at the South Baltimore Car Works.

The Baltimore & Ohio Southwestern contemplates building some coal cars, but the contract has not yet been received.

Boiler Pitting Cured by Graphite and Oil.

In the *American Machinist* of July 28, Mr. T. T. Parker has a very interesting article regarding pitting in boilers. Besides some theories, he has this to say from a practical point of view: "In a boiler of the porcupine persuasion pitting was found in the mud drum. Acting under advice, the drum was cleaned and scraped, after which it was painted with graphite mixed with cylinder oil. Measurements of the depths of the pits were taken, and six months after they were found no deeper, and no new ones had shown up. Other parties have since tried this

experiment in mud drums, but it is too early as yet to give the result. However, knowing the character of plumbago, if the interior of a boiler could be painted with it in such a way that it would stay it may be this would prove a remedy. I am satisfied also that the person doing so would kill two birds with one stone, as the scale could be easily detached. In a pair of cylindrical boilers 42 × 28 occasional applications of cylinder oil (mineral) and plumbago have kept back corrosion on a trial of six months. Boilers were new when plumbago was used. The boilers which the new ones replaced were thrown out rotten from corrosion. The feed was mine water, as nothing else could be had.'

In addition to Mr. Parker's remarks we add that Harig, Koop & Company, Louisville, Ky., after experiencing more or less trouble from rust and scale in the mud drums of their boilers, applied with great success graphited oil, purchased from the Joseph Dixon Crucible Company, Jersey City. The mud drums were cleaned out and the graphited oil applied with swab, brush, or anything handy, to the joints and parts where the water enters the drums. Every four or six weeks this process is repeated with the most gratifying results.

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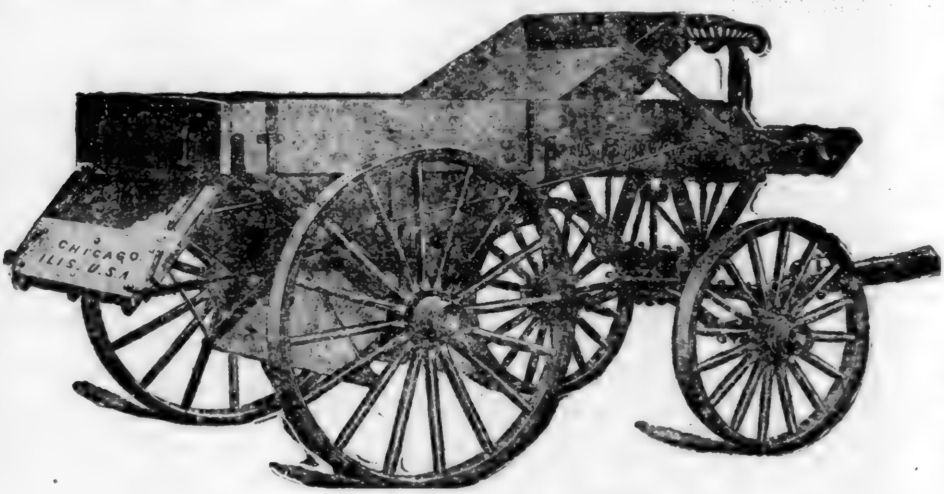

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of 16 ft.; speed, 14 miles an hour; engines, triple expansion; diameter of cylinders, 24, 39 and 63 by 48 in. stroke; three Scotch type boilers 12 × 12 ft., tested for 175 lbs. steam; and the usual auxiliary machinery and modern equipment, including an electric light plant. The steam windlass, capstans and steam steering gear, as well as the main engines and boilers, propeller wheel, etc., are all from the works of her builders. The *Maritana*, a sister ship, recently took the largest cargo on record on the lakes, carrying 4,218 tons of iron ore from Escanaba on 17 ft. 6 in. draft.

PLANS have just been completed by the Detroit Dry Dock Company for the two side-wheel steamers they will build for the Detroit & Cleveland Steam Navigation Company, to take the place of the *Alpena* and *Mackinaw*, sold to Cleveland parties recently. The *Review* is favored with the first information concerning them. They will be 264 ft. on the water-line, 38 ft. beam, 69 ft. over the guards, and 15 ft. deep. The length is about 6 ft. and the beam 3 ft. less than the *City of Cleveland*, the furnishing, fittings, finishing, and general arrangement of which will be duplicated in the new boats. The engines will be walking-beam compound, built by Fletcher, New York, the high-pressure cylinder being 42 in. diameter by 7 ft. 5 in. stroke, and the low-pressure cylinder 66 in. by 11 ft. stroke. Steam will be supplied by four 11 × 11-ft. boilers, an important auxiliary being furnished in Howden's system of forced draft. This will result in the boats being faster than the two running between Detroit and Cleveland, which make 18 miles an hour when desired. While the builders are very conservative, it is thought that they will not object to the statement that the new boats will make 19 miles an hour. The most peculiar thing about the new boats is that each will have a rudder in the bow—not in front of the bow. As far back as 8 ft. the stem of these boats will not be over 12 in. thick, and the rudder will consist of a portion of the stem being fixed so that it will swing to port or starboard, as desired. This will enable the boats to run up the river at Alpena or Cheboygan, or into any harbor, and back out without the aid of a tug. It is a valuable contrivance, and there is no reason why it will not work.—*Cleveland Marine Review.*

THE Chicago Ship Building Company, South Chicago, Ill., has taken a contract to build a large steel steamer for Chicago parties. The general dimensions will be 310 ft. over all, 290 ft. keel, 41 ft. beam and 24 ft. 8 in. molded depth. She will have two Scotch boilers 12 × 12 ft., and a triple-expansion engine with cylinders 19 in., 32 in. and 52 in. by 52 in. stroke.

THE Frontier Iron Works, Detroit, Mich., recently completed a triple expansion engine, with cylinders 23 in., 37 in. and 62 in. in diameter by 44 in. stroke, for the steamer *W. H. Gilbert*, and are building another of the same size for the new steamer *Pathfinder*.

General Notes.

THE Grant Locomotive Works, Chicago, Ill., are building five switching engines, with 16 × 22-in. cylinders, for the Chicago, Milwaukee & St. Paul road.

THE Baldwin Locomotive Works, Philadelphia, are building 10 ten-wheel freight locomotives for the New York, Chicago & St. Louis Railroad. Nine of them have 18 × 24-in. cylinders; the remaining one is a four-cylinder compound engine of the Vauclain type. These shops have also recently taken contracts for two simple and two compound freight engines for the Toledo, Ann Arbor & Northern Railroad, and for 10 compound consolidation engines for the Lehigh Valley Railroad.

THE Cooke Locomotive Works, Paterson, N. J., are building three standard passenger engines and one heavy switching engine for the Delaware, Lackawanna & Western Railroad.

THE lubricating pads of the Automatic Lubricator Company have had a successful trial on the Pennsylvania Company's lines. The New York, New Haven & Hartford Company has recently ordered 1,800 to complete the equipment of its locomotives and tenders.

THE Pullman Shops, Pullman, Ill., recently delivered 15 first-class passenger and two combination cars to the Chicago, St. Paul, Minneapolis & Omaha Railroad. These cars are equipped with steam-heating apparatus and Pintsch gaslights, and have Scarritt-Forney seats.

THE Lodge & Shipley Machine Tool Company has been organized in Cincinnati with $100,000 capital stock, the officers being William Lodge, President and General Manager; Murray Shipley, Jr., Vice-President and Secretary. The new company succeeds to the plant and business of the Ohio Machine Tool Works, owned by Mr. Lodge, and will manufacture turret lathes of a new special pattern, besides a variety of lathes and other tools and special machinery for boring and turning pulleys, couplings, and similar work.

THE firm of Westinghouse, Church, Kerr & Company, Engineers, have closed an important contract with the Standard Refrigerating Company of Boston. This Company is the manufacturer of the Hodges & Havenstrite system of refrigeration and ice-making, and Westinghouse, Church, Kerr & Company have secured exclusive control of the sale of this apparatus in the United States, which they have added as a separate department to their contracting business. A large number of orders, particularly in the direction of manufacturing artificial ice, are already booked, and the work is under construction.

THE firm of B. M. Jones & Company, of Boston and New York, are now furnishing the brand of "R. Mushet's special" steel in annealed blanks for use in milling cutters, taps and dies, reamers, twist drills, and similar purposes. The quality and uses of this brand are well known.

THE shops at Hegewisch, Ill., and at Anniston, Ala., formerly owned by the United States Rolling Stock Company, have been turned over to the new corporation which has been formed to carry on the business of that concern, and which is known as the United States Car Company. Mr. George W. Ristine, who is well known among railroad men, has been chosen President of the new company.

THE E. P. Allis Company, Milwaukee, Wis., has the contract for the engines in the new power-house of the electric railroad in Brooklyn, N. Y. It includes six compound engines with cylinders 32 in. and 62 in. × 60 in., which will work up to 2,000 H.P. each, and eight compound engines, with cylinders 26 in. and 48 in. × 48 in., which will work up to 1,000 H.P. each. The working pressure will be 140 lbs. The engines will be connected directly to the dynamos, the armatures taking the place of the fly-wheels of the engines.

THE Dietz passenger draw-bar, to which reference was recently made, is to have a very severe trial, having been put on a passenger train running on the narrow-gauge branch of the Union Pacific from Denver, Col., to Grant. This line runs up the Platte Cañon, rising 4,000 ft. in a distance of 40 miles, and is almost a constant succession of curves, many of which are very sharp. On this line there has been considerable trouble with trains breaking in two. So far the new coupler has given very good results.

A CONFERENCE or convention was held recently by a number of the employés of the Consolidated Car Heating Company, who met at the new factory in Albany, N. Y., and spent two days in carrying out a carefully arranged programme, which covered a discussion of the theory of hot water and direct steam heating in all its branches, and was accompanied by practical illustrations of the working of apparatus under steam and fire. The fourth floor of the new factory has been especially arranged for the purpose of testing and experimenting, and on this floor full-sized apparatus of all varieties has been put in and was seen in operation. A paper was read giving a full description of the construction and operation of the appliances, then possible errors in equipment, which were to be guarded against, were pointed out, and following this questions were asked by all present. Advance sheets of the Company's new catalogue were submitted, and several new devices which are to be put upon the market this season were exhibited and discussed.

Lunch was served each day in the offices of the Company. Part of the time was spent in the careful consideration of the present aspect of business, and encouraging reports were received from all directions.

THE car works of Murray, Dougal & Company, Milton, Pa., are completing an order for 1,000 double-hopper gondola cars for the New York Central. They are also building a lot of oil-tank cars.

THE Berlin Iron Bridge Company, of East Berlin, Conn., is putting up two iron buildings for the Randolph & Clowes Company, at Waterbury, Conn., one a casting shop 42 ft. wide by 82 ft. long, and another a pickle room 25 ft. wide by 100 ft. long. The Berlin Company is also building a new gas house for the Philadelphia & Reading Railroad at Philadelphia, and a new retort house for the George H. Morrill Company, of Boston. All of these buildings are to be of iron, after the well-known plans of the Company.

THE new foundry and warehouse now being built by the Westinghouse Air Brake Company, at Wilmerding, Pa., were

to be completed and ready for operation by October 1. About 600 additional men will be given employment in the new foundry as soon as it is completed.

The Berlin Bridge Company has the contract for a new bridge over the Connecticut River at Suffield, Conn. It will have five spans of 210 ft. each, and will carry a roadway 20 ft. wide.

The Midvale Steel Works, Nicetown, Philadelphia, are building a new machine shop 20 × 112 ft. in size, which will contain some very heavy tools, including a lathe which will carry work 90 in. in diameter and 50 ft. long between centers. It will be used chiefly on heavy Government work.

The largest wooden sailing ship ever built in the United States was recently launched from the Sewall yard at Bath, Me. She is named the *Roanoke*, and is 311.2 ft. long, 49.2 ft. beam, 29.2 ft. deep, and is of 3,530 tons measurement. She has four masts.

The Harlan & Hollingsworth Company, Wilmington, Del., recently completed the twin-screw steamer *Richard Peck* for the line between New York and New Haven. On her trial trip this boat attained a speed of 20¼ miles an hour. The dimensions of this steamer are: Length on water-line, 300 ft.; length over all, 316 ft.; breadth of beam on hull, 48 ft.; breadth over guards, 62 ft.; depth of hold, 18½ ft.; draft, 10½ ft. She has two triple-expansion surface-condensing engines, with a diameter of cylinders of 60, 38 and 24 in., 30 in. stroke. Steam is furnished by six steel Scotch boilers, 12 × 12 ft., with 400 ft. of grate surface. She is handsomely fitted up and lighted by electric light.

The latest addition to the fleet of propellers on Long Island Sound is the *Nutmeg State*, built for the Bridgeport Line by Robert Palmer & Sons, of Noank, Conn. She is 200 ft. long over all, 183 ft. on water-line, 34 ft. beam and 9 ft. mean draft. She has ample accommodations for passengers. There are two steel boilers 9 ft. 4 in. diameter and 20 ft. long, each having two corrugated furnaces. The engines, built by J. W. Sullivan, of New York, are of the vertical triple-expansion type, with cylinders 18 in., 27 in. and 42 in. in diameter and 28 in. stroke.

PERSONALS.

A. B. Palmer has been appointed Superintendent of Water-Works at Green Bay, Wis.

Daniel W. Shea, recently of Harvard, has been appointed Professor of Physics in the University of Illinois.

William J. Gillingham, Jr., has been appointed Signal Engineer of the Illinois Central Railroad, with office in Chicago.

Commander French E. Chadwick, U. S. N., has been assigned to the charge of the Bureau of Naval Intelligence in the Navy Department.

Benezette Williams is now Chief Engineer of the Chicago drainage canal, with Thomas T. Johnson and B. C. Dunlap as his principal assistants.

W. T. Manning is now Chief Engineer of the Baltimore Belt Line, succeeding Major Richard Randolph, who has been appointed Consulting Engineer.

Professor Arthur T. Woods, recently of Washington University, in St. Louis, is now connected with the *Railroad Gazette.* He will have his office in Chicago.

Charles L. Heisler, M.E., has given up his office as Consulting Engineer in Dunkirk, N. Y., and is now connected with a large manufacturing concern in Philadelphia.

William H. Burr, formerly Professor in the Rensselaer Polytechnic Institute, but for some years past in active practice as a civil engineer, has accepted a professorship in the Lawrence Scientific School of Harvard University.

Charles W. Scribner has been appointed Professor of Mechanical Engineering in the University of Illinois. He is a graduate of Stevens Institute, and for four years was Professor of Mechanical Engineering in the State Agricultural College at Ames, Iowa.

The Offices of the Moffett, Hodgkins & Clarke Company, Consulting and Constructing Engineers and Contractors, have been consolidated and established at Nos. 16–22 William Street, New York City. The offices have heretofore been in Syracuse, N. Y., with a branch in New York City.

Professor J. B. Johnson, of Washington University, in St. Louis, has been chosen a Vice-President of the American Association for the Advancement of Science, and Chief of the Section of Mechanical Science and Engineering. Professor Olin H. Landreth, of Vanderbilt University, Nashville, Tenn., has been chosen Secretary of that section.

R. H. Hood has been appointed Professor of Civil Engineering in the University of Missouri. He is a graduate of the Rensselaer Polytechnic Institute, and has had much practical experience, having been engaged in railroad, canal and mining surveys in various capacities, and having served for several years as Chief Engineer of the Seaboard Air Line.

John Fritz, Chief Engineer and Superintendent of the Bethlehem Iron Company, has recently passed his 70th birthday, and to commemorate that date a number of his friends, members of the Engineers' Club, met in Bethlehem, Pa., September 28, and entertained Mr. Fritz at dinner at the Wyandotte House. Many congratulations were extended him on his continued good health and the great success of the works under his charge.

OBITUARIES.

Frank C. Avery died suddenly September 10, on board an express train while on his way from New York to Flat Rock, N. C., on a vacation trip. He was Secretary and Manager of the New York Railway Supply Company, and had many friends, who will regret his untimely loss.

John H. Handren, who died in Brooklyn, N. Y., September 5, aged 60 years, was for many years engaged in the building of marine engines in New York and Brooklyn, and had made a reputation as a marine engineer and skillful machinist. He was head of the firm of Handren & Robins, and a large number of steamers of various sizes have his engines in them.

James B. Francis, who died at his residence in Lowell, Mass., September 18, aged 77 years, was born in England, but came to this country at an early age. When still a young man he entered the service of the Locks & Canals Company, which controlled the great water-power of the Merrimac at Lowell, and remained with that company for many years, becoming its Chief Engineer. For some time past he has been Consulting Engineer. Mr. Francis had secured a high reputation as a constructing and hydraulic engineer; he served one term as President of the American Society of Civil Engineers, of which he was one of the oldest members.

Colonel Stephen States Lee, who died at his residence near Baltimore, August 25, aged 80 years, was born in South Carolina and educated as a civil engineer. In 1835 he was employed in building the old Stonington Railroad, now the New York, Providence & Boston, and served also on other eastern and western lines. In 1843 he became interested in the Cumberland coal fields in Maryland, and for many years was employed there as consulting engineer on mining and railroad work, and later as Manager of the Mt. Savage Coal Company. Nearly 20 years ago he retired from business with a considerable fortune, and since then has spent a large part of his time in France.

General Joseph R. Anderson, of Richmond, Va., died September 7, at the Isles of Shoals, where he was spending the summer. He graduated from West Point in 1832, and served for a number of years in the Engineer Corps of the Army, which he left to assist in the establishment of the celebrated Tredegar Works, in Richmond. During the war he was in the Confederate service for a short time, but was for most of the time engaged in the management of his works, which supplied material for the Confederate Army. Since the war he has been President of the Tredegar Company, and until very recently has retained the active management of the works. Although he was 80 years old at the time of his death, his business activity was but little abated. He leaves a large fortune.

Colonel Eben C. Smeed, who died in Philadelphia, August 24, aged 61 years, was born in Windsor, Vt., and at an early age began work in an engineer corps in Northern Pennsylvania. He was employed for a long time on the Erie Railroad, and was Assistant Engineer in the building of the old Portage Viaduct. Later he was on the Delaware, Lackawanna & Western, and built the large stone arches near Scranton on that road. In 1861 he entered the Army and served throughout the war, being most of the time Assistant to General Haupt in the Department of Military Transportation. Later he was on

General Thomas's staff, and had charge of the reopening of the railroads when the advance to Chattanooga and later to Altoona was made. At the close of the war he declined a commission in the Engineer Corps, and in 1866 became Resident Engineer of the Kansas Pacific, being shortly afterward appointed Chief Engineer. When that company was consolidated with the Union Pacific, he was made Assistant Chief Engineer, and held that position until he became Chief Engineer on the retirement of Mr. Bogue in 1891. Mr. Smeed was noted among engineers for his readiness in emergencies and his fertility in expedients, and distinguished himself both during the war and while on the Kansas and the Union Pacific.

At a meeting held September 6, 1892, at the office of the Consolidated Car Heating Company, Albany, General Manager Sewall announced the death of Mr. Leighton, and after a few remarks Vice-President Rice offered the following minute, which was seconded by Mr. James F. McElroy and adopted:

"The officers and employés of the Consolidated Car Heating Company learn with sorrow of the death of their associate, Mr. James T. Leighton, of New Haven, and at this their first meeting since that sad event desire to put upon record an expression of appreciation of the admirable qualities which endeared Mr. Leighton to so large a circle of friends. Though in the last few years failing health made him able to take up only part of that full measure of service which formerly brought him in active contact with railroad men throughout the country, yet whatever work fell to him was always done cheerfully, and wherever he came he was always accorded a generous welcome.

"His life was that of a Christian gentleman, continually thoughtful for others. His loss will truly be felt in many places outside his own family. We deeply sympathize with those of his own household, and trust that these few words may in slight degree convey to them the affectionate regard in which James T. Leighton was held by those who knew him best in business life during the few years just past."

PROCEEDINGS OF SOCIETIES.

New England Roadmasters' Association.—The 10th Annual Convention of this Association began in Springfield, Mass., August 25. The usual reports of the officers were presented, and the following officers were chosen for the ensuing year: President, C. B. Lentell, Boston & Albany; Vice-President, F. H. Holbrook, New York, New Haven & Hartford; Chaplain, E. W. Horner; Secretary and Treasurer, G. L. R. French, Boston & Maine; Executive Committee, W. T. Mosher, F. C. Clarke, T. B. Bodwell and F. E. Sibley.

Reports were then presented by the different Committees on Heavy and Light Rail Sections; on the Best Material and Form for Small Culverts and Cross Drains; on Fire Damages, and on the Use of Cheap Material and Tools.

In the evening the Association held its annual dinner, at which about 80 members were present. In the course of this a testimonial was presented to William F. Ellis, who was for seven years Secretary of the Association.

On the second day Mr. W. F. Ellis read an interesting paper on Rail Sections, which was illustrated with drawings, and in the course of which the strong and weak points of different sections were pointed out. The Committee report, which was in favor of the use of heavier rails, was discussed by the members, and was generally approved. The general opinion was also in favor of the use of tie-plates.

The Committee on Small Culverts and Cross Drains reported, recommending several forms of culvert. Their report was also discussed, and several plans for building culverts were suggested. The use of iron pipe was also recommended by a number.

The report on Fire Damage was accepted without discussion. The Committee recommended frequent and careful inspections and the keeping clean of the right of way. The remaining Committee report denounced strongly the practice of purchasing cheap goods of inferior quality.

After passing the usual resolutions of thanks, and deciding to hold the next convention in Boston, the Association adjourned. The meeting closed by an excursion to Greenfield on a special train over the Connecticut River Railroad.

Master Car-Builders' Association.—A circular from Secretary John W. Cloud announces the results of the letter-ballots ordered by the last Convention.

On the first—the change in the Wheel Guarantee—there were 503 votes in favor and 311 against. This change is therefore rejected, having failed to receive the two-thirds vote required.

The second—the standard M. C. B. Coupler Gauges—was adopted, receiving 764 votes, with only 49 in opposition. These are the gauges submitted by the Executive Committee, which were described and illustrated in the Journal for August last, page 386.

A circular from Secretary John W. Cloud gives the subjects and committees for the Convention of June, 1893. There are four committees on the M. C. B. Standards as follows:

1. Drawbars and Brake-beams.—To consider the suggestions of the Committee on Standards, as to standard height of Drawbars, and as to standard form of Brake-beam, and report with recommendations and drawings in detail. Committee: E. D. Nelson, John Bean, J. R. Rankin and C. A. Schroyer.

2. Axles, Journal Boxes, Lids and Wedges.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee: R. H. Soule, W. H. Day and W. H. Lewis.

3. Truck Pedestals and Safety Chains.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee: T. A. Bissell, William McWood and A. E. Mitchell.

4. Protection of Trainmen and Lettering Fast Freight Line Cars.—To consider the suggestions of the Committee on Standards, and to recommend in detail, with drawings, how these standards should be modified and published. Committee: E. P. Lord, Robert Walker and Thomas Sutherland.

The committees other than those on Standards are as follows:

5. Tests of M. C. B. Couplers.—To arrange for and conduct the tests, as proposed by the Committee of 1892 and approved by the Convention, and to consider and report upon all other questions connected with the M. C. B. coupler which they might consider advisable, with the exception of the attachment at the rear end of the coupler and the form of the coupler at that point. To confer with the Committee on Attachment of M. C. B. Couplers to Cars. Committee: J. M. Wallis, J. S. Lentz, R. D. Wade, J. H. McConnell, E. Chamberlain and T. G. Duncan.

6. Attachment of M. C. B. Couplers to Cars.—To recommend a form, in detail, of M. C. B. coupler at rear, and so as to take yoke, tail bolt and continuous draw-bar attachments; also to consider and report upon the best form of draft attachment to cars. To confer with Committee on Tests of M. C. B. Couplers. Committee: E. D. Bronner, W. H. Harrison, A. M. Waitt, William Garstang, A. Dolbeer and John H. Davis.

7. Metal for Brake Shoes.—To investigate the relative friction and wear of different metals and different shoes in general use on chilled treads and on steel tires. Committee: William Forsyth, Benjamin Welsh and F. D. Adams.

8. Cast-Iron Wheels.—To investigate and report whether there is any substantial difference in wheels made by different methods, such as by solid chills or contracting chills, or by any other difference in process of manufacture. Committee: G. W. West, W. H. Thomas and John Player.

9. Steel-Tired Wheels.—To investigate further and report with all data available as to relative values in service. Committee: R. E. Marshall, J. O. Pattee and C. H. Cory.

10. Air-Brake Tests.—To further investigate and report in detail what tests are desirable to insure best available service. Committee: G. W. Rhodes, E. B. Wall, George Gibbs, A. S. Vogt and E. A. Williams.

11. Freight-Car Truck Frames.—To include in its report the relative advantages of fixed bolsters and swing bolsters. Committee: J. C. Barber, W. S. Morris and S. A. Crone.

12. Steel Center Sills.—To consider and report whether the use of steel for center sills in freight cars would be desirable. Committee: D. L. Barnes, J. N. Barr and J. D. McIlwain.

13. Steam Heating and Ventilation of Passenger Cars.—To review the report of last year's committee on this subject, which was acted on provisionally, and to recommend any changes that may be deemed proper; also to further pursue the subject of steam heating in general, informing the Association as to what improvements, if any, is being made over the methods now in use. Committee: L. B. Paxson, J. J. Hennessy, Joseph Townsend, John Hodge and David White.

Master Car and Locomotive Painters' Association.—The annual convention began at the Russell House, in Detroit, Mich., September 14. President J. A. Goheen delivered the annual address, and the Secretary presented his report, showing 122 active and 32 honorary members, with a balance of $111 in the treasury.

The election of officers resulted as follows: President, William O. Quest, of Pittsburgh; Vice-President, William J. Orr,

of Rochester, N. Y.; Second Vice-President, W. T. Leopold, of Savannah, Ga.; Secretary and Treasurer, Robert McKeon, of Kent, O. Mr. McKeon has held this position in the Association for 18 years.

At the evening session and at the two sessions of the following day the committee reports were presented and discussed, according to the programme which was published in the September number of the JOURNAL. A number of questions submitted by members were also discussed.

The attendance at the meeting was very good; some valuable papers were presented, and the discussions called out many notes of practical experience, showing that the Association is actively maintained by the interest of its members.

American Society of Civil Engineers.—The first regular meeting of the season was held on the evening of September 7, President Mendes Cohen in the chair. The Secretary read papers on the Increasing Cost of Railroad Tie Renewals, by Benjamin Reece, and on Thin Floors for Bridges, by Albert F. Robinson. These papers were received early enough for presentation to the annual convention, but were not then read or discussed on account of lack of time. According to the decision of the Board these papers will be immediately published in the *Transactions*, but written discussions will still be received.

Mr. Reece's paper was briefly discussed by Mr. Cohen, and Mr. Robinson's by Messrs. T. C. Clarke and George S. Morison.

It was announced that the Board of Direction by an unanimous vote elected William Hazel Wilson as an honorary member. Ivor Ludwig Sjöstrom, Chehalis, Wash., was elected by the board to Junior membership.

The election by letter-ballot of the following candidates was announced:

Members: Cary Calvert Barr, Jersey City, N. J.; George William Catt, New York; James Edgar Denton, Stevens Institute, Hoboken, N. J.; Theodore Semenovitch Shmeleff, Reval, Russia.

Associate Members: Walter Eugene Angier, Memphis, Tenn.; Austin Lord Bowman, Roanoke, Va.; Loomis Eaton Chapin, Canton, O.; Edward Wilkins Dewey, New York; Frank Lynwood Garrison, Philadelphia, Pa.; Alva Jarvis Grover, Omaha, Neb.; Dunkin Wirgman Hemming, Baltimore, Md.; Peter Elbert Nostrand, New York; Max Ernst Robert Toltz, St. Paul, Minn.; Maurice Augustus Vielé, New York; George Smedley Webster, Philadelphia.

AT the regular meeting on September 21 two papers were presented, one on Strength and Weathering Qualities of Roofing Slates, by Professor Mansfield Merriman. The second was on Tests of Power Required to Drive Electric Street Cars, by Louis B. Bonnett.

New York Railroad Club.—At the first meeting of the season, in New York, September 15, Mr. Hugh Baines read a paper on Rolling Stock in its Relation to Track. This was followed by a paper on Boiler Scale and Purification of Feed Water, by Mr. F. A. Stinard. Both papers were discussed by members present.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, September 2, William A. Doble and C. P. Feusier were elected members.

Mr. M. B. Kerr, of the Geological Survey, read a paper on the Geographical Position and Height of Mount St. Elias, Alaska. In this the reader gave an account of his personal experiences while making the ascent, and discussed at length the difficulties standing in the way of an accurate measurement of the height of Mount St. Elias. The lecture was illustrated by stereopticon views.

NOTES AND NEWS.

The Hurontario Ship Railway.—At the last session of the Ontario Legislature an act was passed incorporating the Ontario Ship Railway Company. The project of this company is to build a three-track railroad from Toronto on Lake Ontario, to Collingwood, on Georgian Bay, in Lake Huron, for the purpose of hauling lake vessels between those two points.

Simply stated, the plans provide for basins or docks at the terminals, which can be emptied and filled at will, and where the vessels can be floated on and off the enormous car designed to transport them. On the car the vessels will rest securely on cradles. The car itself will be drawn by six or more powerful locomotives.

The Ontario Ship Railway will be about 66 miles long, and will run from Collingwood, on Georgian Bay, to the mouth of a small river west of Toronto. Georgian Bay is an arm of Lake Huron, and this ship railroad would make a new route between Lake Huron and Lake Ontario, by cutting off the round-about course through Lake Huron, St. Clair River, Lake St. Clair, Detroit River, Lake Erie and the Welland Canal, or any part of the route.

Immense adjustable cradles are fitted, or to be fitted, on three railway tracks of the standard gauge, and by this means vessels of all forms or size may be conveyed from basin to basin.—*Marine Record.*

This is the project advocated by Mr. Corthell, of Chicago. The route is one which must have suggested itself to any one who has studied a map of the lakes; the method of building it was the question to be studied.

The New Cunard Steamer.—The *Campania*, the first of the new Cunard steamers, was launched September 8, from the yard of the Fairfield Company, at Govan, Scotland. She is the largest steamer ever built, except the *Great Eastern*, being 600 ft. long and 75 ft. beam, and will, when fully loaded with cargo, passengers and stores, have a displacement which is estimated at over 19,000 tons. This is a displacement by at least 3,000 tons greater than that of any ship, merchant vessel or man-of-war now in existence. It is anticipated that upon her trials, when loaded to a displacement of something over 14,000 tons, she will attain a speed of 23 knots, or nearly 26½ land miles per hour; and she will, not improbably, exceed even this. Upon her voyage she is to make a continuous speed from port to port of 21 knots, or 24.1 land miles, and this speed is tolerably certain to be improved upon after she has made a few trips. Her engines are ready for her, but no part of them will be put on board until she is in the water. The machinery consists of twin phosphor-bronze screws driven by two triple-expansion engines, each capable of indicating up to 15,000 H.P. Each engine has two cranks and five cylinders. Two high-pressure cylinders will exhaust into an intermediate cylinder, which will exhaust into two low-pressure cylinders; and the pistons of these last are on the same rods as the pistons of the high-pressure cylinders. There will be 12 double-ended boilers, each with eight furnaces, and there will be six stokeholds. The funnels, two in number, will be the largest ever made. The rudder, formed of a single steel plate, is so wide that no British firm possessed the necessary machinery for rolling it, and the work had, in consequence, to be entrusted to Krupp, of Essen.

An American Exhibit in South Africa.—A concern known as the Mercantile Corporation of the United States and South Africa, Limited, has made arrangements to hold a permanent exhibition of American manufactures in Cape Town, the capital of the South African Colonies, with the object of building up and increasing trade between the two countries. All kinds of machinery will be shown, and the purpose is to make the exhibit an interesting and valuable one. The company is organized for the purpose of conducting and developing trade. Mr. R. H. Allen is the Secretary at Cape Town, and the agency in the United States is held by the firm of Haase & Vaughan, of No. 140 Pearl Street, New York City.

Prize for Electrical Investigations.—At the last prize contest instituted by the City of Paris for the best electric meter, the prize of 5,000 francs was awarded to Professor Elihu Thomson. With the desire that this sum should serve for the development of the theoretical knowledge of electricity, Professor Thomson requested Mr. Thurnauer, the European Manager of the Thomson-Houston Company, to offer a prize for the best work on some theoretical question in electricity and to organize a committee to propose the subjects, examine the productions and award the prize. The Committee which has been selected is composed of eminent French electricians, and has decided that the prize should be given for an investigation on one of the following subjects:

1. The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dieletric and quantity of charge.

2. It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally under conditions such that the exact measure of resistance, capacity and coefficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula.

3. When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally.

4. It is proposed to arrange and systematize our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods as in graphical statics.

The theses presented may be written in English, French, German, Italian, Spanish or Latin. They may be in manuscript, or printed.

Each thesis presented must be signed by a pseudonym and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside.

The papers must be sent before September 15, 1893, to B. Abdank-Abakanowicz, Consulting Engineer, the Secretary of the Committee, at 7, Rue du Louvre, Paris, who will furnish any further information required.

A Handy Reading Chair.—The illustration annexed shows the construction of a chair for use in reading, which is said to be very nearly a representation of one preserved at Walmer Castle, which was used by the Duke of Wellington. The

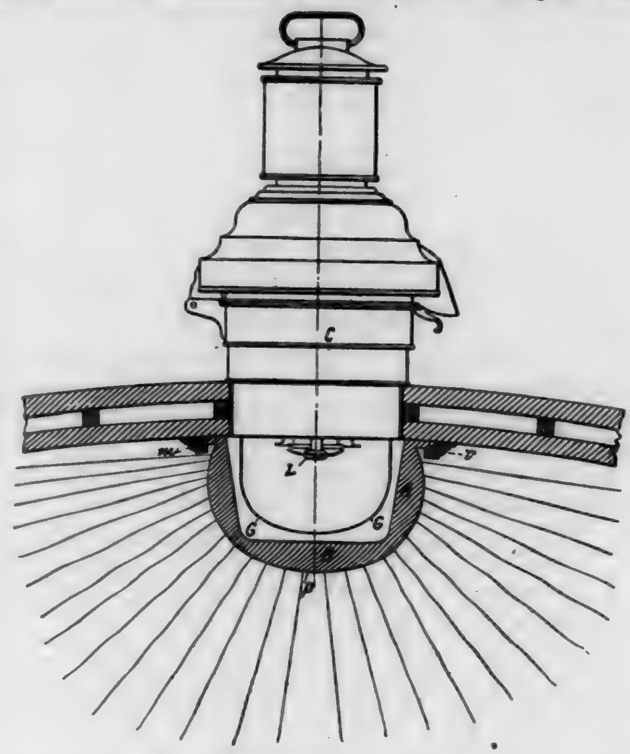
A PECULIAR READING CHAIR.

illustration explains itself. The seat may be stuffed and upholstered to suit, and the desk can be made to rest at any desired inclination.—*English Mechanic.*

A Railroad Car Lamp.—The accompanying drawing shows a form of lamp for cars which has recently been patented by August Nieuwenhuys, of Brussels, Belgium. The object is to increase the brightness and steady the vacillating light generally found in railway carriages or coupés by concentrating the luminous rays emitted by the lighting appliances, of whatever kind they may be, by means of a glass or crystal projector of special lenticular construction, which is applied around the usual glass globe of the lamp. By this means is obtained a much more intense and steady light, less fatiguing to the eye, and enabling one to read easily when at present no reading is possible.

In the drawing the arrangement is shown in section, as applied to the ceiling of a car, with a lamp of any kind. In this drawing *L* is the lamp inserted in the ordinary chimney *C*; *G* is the ordinary glass globe which incloses it, and *P* is the projector or globe of concentration, which is suspended by a flange *r* in a circular groove *m*.

In order to effect concentration of the light, the walls of the projector must be of lenticular form, such that the light is projected and concentrated in all directions. It is therefore necessary to combine several lenticular bodies, the surface of the whole of these being approximately that of a sphere concentric with the flame or illuminant. In the present example the problem is solved by combining a lenticular convex ring *A*, some-



NIEUWENHUYS' CAR LAMP.

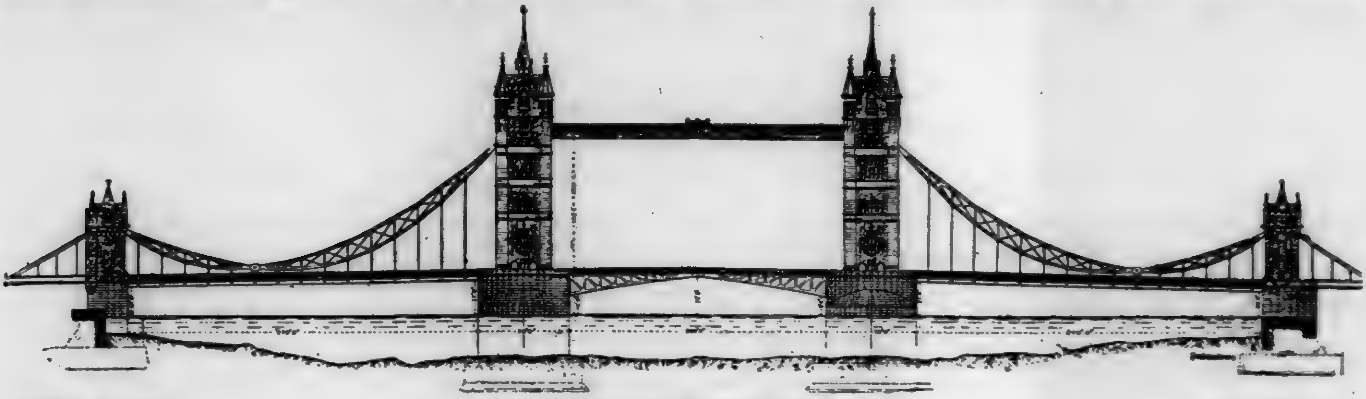
what conical in section, with a horizontal convex lens *B*, forming the bottom, the whole being a kind of globe which can easily be made in one piece and the external spherical surface of which accurately reflects all the luminous rays in all directions.

It might be objected that by the use of the projector *P* the ordinary globe becomes superfluous and that the projector alone would suffice; but there would be a serious inconvenience in doing away with the glass globe, because the heat of the lamp *L* would be received directly on the projector *P*, which might cause it to crack, particularly along the line of junction of the lenticular ring *A* with the lens *B*, the thickness of glass along this circle being out of proportion to the rest. This risk is completely avoided by retaining the globe *G*, which prevents the heat from reaching the projector, the temperature of which remains the more uniform as its interior is ventilated by its communication with the chimney *C*. The result is therefore attained simply by applying the globe to a lamp of any nature or construction for perfectly lighting a railroad car.

The Tower Bridge.—The accompanying illustration, from *Industries*, gives an elevation and plan of the Tower Bridge, now in course of erection over the Thames in London. Of this bridge *Industries* says: "Probably the same weight and exceptional workmanship have never been crowded into so small a compass as in the Tower Bridge. The weight of mild steel in the total structure will be 12,000 tons. Some idea of this quantity may be had from the fact that it is equal to a mass of steel 12 in. thick, 60 ft. wide, and a length equal to that of the bridge. Of this quantity 8 000 tons are already on the works. The approach to the bridge is 70 ft. wide, which is reduced to 60 ft., and further reduced to 50 ft. over the center span. The bridge consists mainly of three spans. The center span, of 200 ft., for the passage of ships, is an opening span on the bascule or lifting type, opening in two leaves. These are balanced on the main piers built in the middle of the river. Each pier carries a series of steel octagonal columns forming a tower, which will be cased with masonry. From these towers are carried two independent foot-bridges at a height of 150 ft. above the water level, and one end of each side suspension span.

"Access will be obtained to these foot-bridges by hydraulic lifts worked inside the towers when the central span is opened for the passage of ships. The foot traffic will thus be continuous at all stages of the tide, but vehicular traffic will be stopped during the time the bascule span is open. The foot-bridges are now continuous across the river from tower to tower. These foot-bridges are 12 ft. wide and about 240 ft. long, and

weigh, together, about 500 tons. They are built on the cantilever principle. A cantilever of 60 ft. projects from each tower, and these carry a central girder of 120 ft. span by means of 6-in. flat steel rods suspended from the ends of the true cantilevers.



Middlesex Abutment FIG 3.—SIDE ELEVATION OF BRIDGE AS COMPLETED *Surrey Abutment*

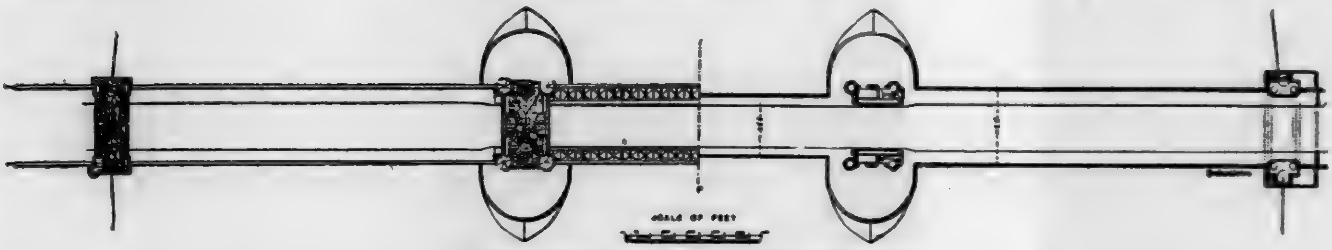


FIG. 4.—SEMI PLANS OF BRIDGE AT TOP AND ROAD LEVEL

THE TOWER BRIDGE OVER THE THAMES, LONDON, ENGLAND.

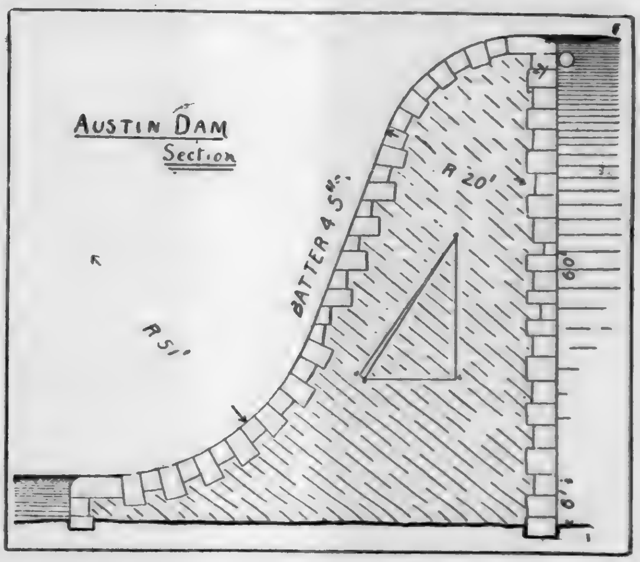
"The center or lifting span is carried by four main ribs from each pivot, meeting at the center of the river. These ribs are 16 ft. 2 in. deep at the haunches, the flanges being 3 ft. wide, and are now being built on their respective piers, end on—that is to say, with the girders pointing up in the air and the span open. Between these main ribs will be fixed cross-girders and buckled plates, on which a wood roadway will be laid. Each leaf of the opening span will weigh 1,000 tons, of which 50 tons was built on a stage rolled forward and turned up vertically. Each leaf measures 113 ft. 3 in. long, and is 50 ft. wide, while it has a counterbalance part weighted with 300 tons of lead. The pivot which carries each leaf is 21 in. diameter, 40 ft. long, and alone weighs 26 tons. The holes in the girders will be bored *in situ*. Each leaf will be raise and lowered by means of a rack having 42 ft. radius worked by means of gearing from hydraulic engines fixed in the body of the pier. The side spans of the bridge are supported by brace girders, each girder being really a huge chain of two links, one end carried on the top of the steel columns on the pier, and the other by similar columns on the abutment. To allow for expansion and contraction of the metal they are carried on roller bearings. The roadway is suspended from these braced girders. From the abutments these braced girders or chains are carried down below the ground and anchored to large foundation girders bedded in a huge mass of concrete. To counteract the pull of the chains on the towers, a horizontal main tie for each chain is carried from tower to tower. Some idea of the magnitude of these ties may be gathered when we state they are 301 ft. long, 2 ft. deep, and 8 in. thick.

"The floor of the side spans is carried by cross-girders pitched 18 ft. apart, suspended by steel rods from the chains. Upon the cross-girders are fixed the bearing or distributing girders, eight in number. Upon these again is fixed a stamped steel corrugated floor, with 7½-in. corrugations and metal ⅜-in. thick.

"The hydraulic power for working the lifts and the two leaves of the center span is generated on the Surrey side of the river. The whole of the machinery for this part of the work is being supplied by Messrs. Sir W. Armstrong, Mitchell & Company, Newcastle-on-Tyne. Mr. J. Wolfe Barry is Chief Engineer.

"The steel octagonal columns forming the towers of the abutments will be cased in with ornamental masonry, and similar masonry will shroud the columns on the piers, a portion of which is completed."

The Austin Dam.—The accompanying sketch shows a cross-section of the dam now in course of erection at Austin, Tex., and is from the report of Mr. J. T. Fanning, Consulting Engineer. This dam will be 1,125 ft. long and 70 ft. high in the center; it is of solid masonry, faced with granite. It is estimated that at high water 250,000 cubic feet of water per second will pass over the crest of the dam, a greater overflow than is known at any dam in the world. The dam will cause a backwater extending some 25 miles up the river, and abundant storage is provided for the dry season. It will furnish a large



amount of power, besides a water supply for the city and for irrigation.

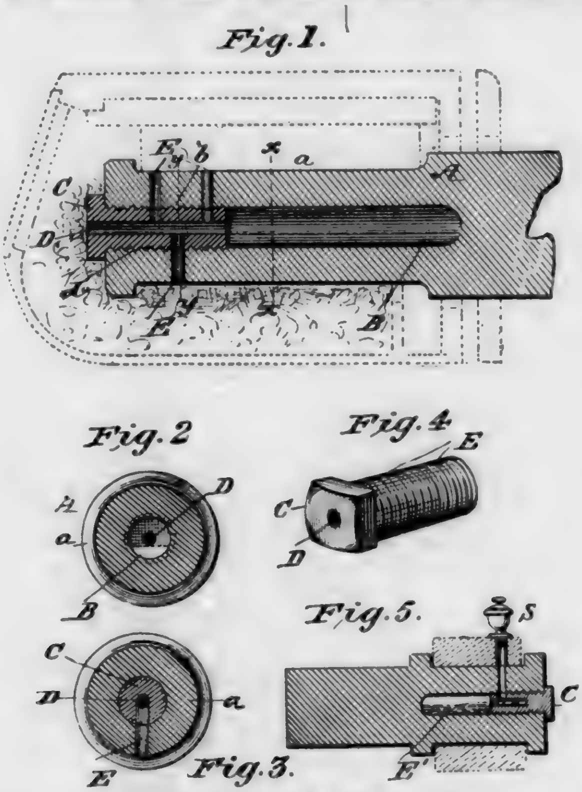
Damming the Rio Grande.—A press dispatch says that a company has been incorporated under the laws of New Mexico for the purpose of putting a big dam across the Rio Grande to store water for irrigating both in Mexico and the United States. William Hamilton, of New York, is at the head of the project, and the company is incorporated for a capital of $10,000,000.

The dam will be built about 5 miles above El Paso in Mountain Gateway. It will be 560 ft. long, of solid masonry from cliff to cliff, resting on a solid limestone foundation, and will be 70 ft. wide.

There will be two double iron gates on the Texas side of the cañon and two of precisely the same size and pattern on the Mexican side. From these gates two canals will be cut through the rock, following the bluff on the Mexican side, capable of carrying a volume of water 20 ft. wide and 10 ft. deep. The cost of the dam and canals is estimated at $2,500,000. The construction of this dam will create an inland lake 15 miles long and about 5 miles wide, with an average depth of about

25 ft. Storage reservoirs will be constructed on both sides of the cañon above, also, so as to replenish the lake from time to time and keep it up to high-water mark.

A New Axle Lubricator.—The accompanying drawings show a new form of axle lubricator, devised and patented by J. T. Connelly, of Milton, Pa. Fig. 1 is a section and figs. 2, 3 and 4 show details. In the drawings *A* designates one end of a car-axle, which is preferably formed with a reduced



CONNELLY'S AXLE LUBRICATOR.

bearing-surface *a*, as usual. Centrally within the axle end is provided a longitudinal bore *B*, extending from the extreme end of the axle to slightly beyond the inner end of the bearing-surface *a* and having at its outer portion interior screw-threads *b*. *C* designates a plug for closing the outer portion of the bore *B*, and to this end it has external screw-threads *d*. The plug *C* is provided with a central longitudinal bore *D*, of greatly less diameter than the bore *B*, and extends from end to end of the plug. One or more bores *E* are provided through the journal and at coincident points through the plug, said bores extending from the bore *D* to the periphery of the axle.

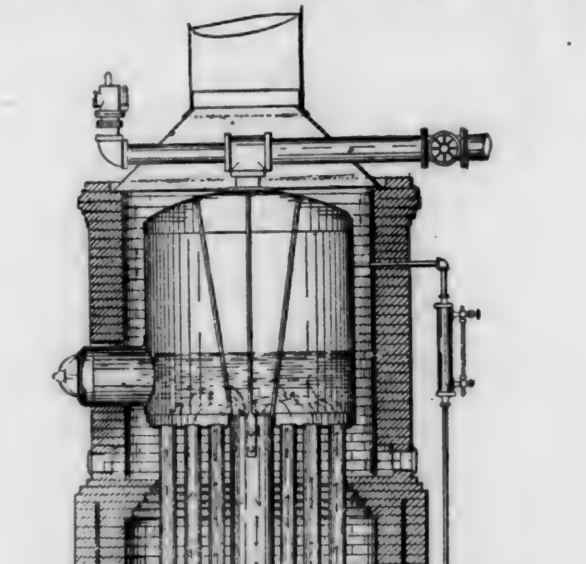
In operation, the axle being journaled in boxes provided with saturated waste, the oil or other lubricant from the latter enters the bore *B* through the bore *D* and finds an outlet through the bores *E*, a certain quantity of the lubricant being at all times held within the bore *B* (in practice about one-third the capacity of the latter) and serving the office of keeping the journal cool. This result is attained by reason of the bore *D*, being of greatly less diameter than the bore *B*, and communication between the latter and the periphery of the axle being had only through the bore *D*, the lubricant when it reaches the level indicated in dotted lines, fig. 1, finds no outlet, the remaining quantity being thus permanently retained within the bore *B*, for the purpose mentioned.

This device can be applied also to crank-pins and similar journals. For such bearings the arrangement is shown in fig. 5; here the outer end of the plug is closed and an oil-cup, *S*, is carried by the bearing for the journal and has its outlet in a direct transverse plane with a bore, *E'*. Thus as the journal revolves the latter bore coincides with the outlet of the oil-cup, and the lubricant passes therefrom to the interior of the journal; but when the bore is removed from the outlet the lubricant is deposited upon the periphery of the journal to lubricate the same.

A New Boiler.—The accompanying drawing, from the *Iron Trade Review*, shows a boiler devised by Herbert F. Cook, of Cleveland, O., for which the advantages of quick steaming, free circulation and freedom from deposit of scale are claimed. A boiler of this class has been in use at the Cherry Valley Iron Works in Leetonia, O., for some time, with excellent results, and others are now under construction.

This boiler is of the vertical water-tube type and is set in brick-work, as shown in the accompanying illustration. One object aimed at is the utilization to the largest degree of the heat applied; another aim is to secure the most complete circulation, and this is accomplished by having all passage ways perpendicular to a direct line to the circulation of water, with no curved passages. This leaves a clear, direct opening from top to bottom of the boiler. There are no flat or horizontal surfaces that sediment can accumulate on, except the bottom of the lower chamber, which is below the effects of the fire, and which is so arranged that water is at all times in circulation. The outer tubes being the thinnest material, containing the smallest body of water and exposed to the greatest heat, the circulation will be upward through these outer tubes and downward through the large flue in the center, in which there is a larger body of water and which is partially protected from the fire by the surrounding tubes; this gives a positive circulation from top to bottom, with separate passage-ways for upward and downward currents of water.

The upper chamber is incased in brick-work, so that there is no radiation of heat, and it acts as a superheater. The tubes are so arranged that they can be taken out and replaced very quickly if necessary, the holes in the tube sheet of the upper



COOK'S TUBULAR BOILER.

chamber being made ⅛ in. larger than the tube, with copper ferrules on so that when the tubes are loosened for the purpose of taking them out, the lower end will cant over far enough to allow them to be slipped down the side of the boiler and passed up between the brick-work and the outer side of the upper chamber.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, NOVEMBER, 1892.

THE address made by Mr. H. G. Haines, as President at the recent meeting of the American Railroad Association, related to the changes needed in the code of train rules to accommodate them to recent changes and improvements in block signal working, and to the necessity of further changes in the system of working crowded lines under block system.

THE long-distance telephone line between New York and Chicago was formally opened October 18. At the New York end of the line a number of invited guests were present and the opening was very successful. The line had, of course, been thoroughly tested, and on this occasion the voices were distinctly heard, and conversation was carried on over the wires without difficulty.

The line used is about 1,000 miles long, and runs from New York to Pittsburgh by way of Easton, Harrisburg, Pittsburgh, Youngstown and South Bend. The poles carry two lines of No. 8 copper wire; the line is very substantially built, with heavy poles and all the latest improvements in the way of insulators and other fittings.

THE new cruiser *Brooklyn*, like the *New York*, will have four engines, two to each screw. At full speed all four will be used, but in ordinary cruising only two will be at work. These engines will be of the vertical triple-expansion type used in most of the new cruisers, and will have cylinders 32, 47 and 72 × 42 in. With 160 lbs. pressure and 130 revolutions they are expected to develop 16,000 H.P.

A peculiar feature of the *Brooklyn* will be the great height of the smoke-stacks. There will be three of these, and they will be carried to a height of 100 ft. above the grate level. Certainly they will be a very prominent feature in the general appearance of the ship.

THE law of the State of New York requires that all freight cars running in the State must be provided with automatic couplers by November 1, 1892. The Railroad Commission, however, acting on authority given it by the same law, has postponed the time for one year, until November 1, 1893. This was done on representations made by a number of the railroad companies that it would be impossible to procure the necessary material and fit up the cars by the time originally fixed.

IN the suit brought by the Interstate Commerce Commission against the Texas & Pacific Railroad, the United States Circuit Court has given an important decision, supporting the ruling of the Commission and fully recognizing its powers and duties under the law. The suit was brought for the enforcement of an order of the Commission, requiring the defendant road to desist from carrying articles of imported traffic shipped from any foreign port, upon through bills of lading, to places within the United States at lower rates than those established by the inland traffic of the road for the carriage of similar articles. The decision is, perhaps, the most important of any given under the law since its passage.

AT a meeting held in Chicago during the ceremonies of the dedication week of the Exposition, a number of gentlemen interested in the subject formed a preliminary organization of a National League for the improvement of highway roads. The object is to establish a central society to secure the co-operation and harmonious working of the different State and local societies formed for the same purpose. The new national league has abundant opportunities for usefulness, and it is to be hoped that it will be well supported.

THE latest addition to the number of States which have held road meetings is Arkansas, whose Convention was held at Little Rock, September 20. A number of papers were presented on the best plans for building and maintaining better highway roads, and the attendance was large and representative enough to secure public attention and to emphasize the public interest in the subject.

THE longest car transfer ferry in the world has been established by the Toledo, Ann Arbor & Northern Railroad, and will run across Lake Michigan between Frankfort, Mich., the western terminus of that line, and Kewaunee, Wis., the eastern terminus of the Green Bay, Winona & St. Paul Railroad. The boats have been especially built for the service and are described in another column. They are intended to meet the various difficulties of the route, including high seas and ice, and are supplied with abundant motive power. The distance run is 63 miles, or considerably longer than that made by the car-ferry across the Straits of Mackinaw.

THE decision of the Lower Court supporting the patent of Mr. Thomas A. Edison for the incandescent light has been upheld by the United States Circuit Court of Appeals, thus giving Mr. Edison and the company with which he is connected the exclusive right to make the incandescent lamp in its present form.

THE construction of steel coal barges for use on the Ohio and the Mississippi has been begun by the firm of W. H. Brown's Sons, in Pittsburgh, who propose to extend it as fast as possible. While the steel barge is much more

expensive than the wooden barges now generally used in the Pittsburgh coal traffic, it will last much longer, and it is calculated that the saving will in the end be considerable. The first barge built is 135 ft. long, 24 ft. beam, and 7 ft. 9 in. depth of hold. From the accounts received, however, it would seem that the construction lacks longitudinal strength. The barge as built is simply a steel box of the dimensions given, and it seems probable that experience will show the need of more bracing than has been considered necessary in the first one.

NOT every city is as fortunate as the town of Boisé City, in Idaho, which has a supply of natural heat ready almost at its doors. It is now proposed to heat the houses of the town by hot water from artesian wells a mile from the city, the water discharged from which comes to the surface in a boiling condition. The main pipe will be 6 in. in diameter and distribution to houses will be made by similar pipes. It is calculated that the cost of heating by this system, including a good profit on the original outlay, will be less than half the present cost with coal.

THE management of the Chicago Exposition are seriously considering the question of transportation of passengers to and from the Exhibition grounds. Many calculations have been made as to the number of passengers for which transportation must be provided. These differ, naturally, but a conservative estimate places the average daily attendance at about 200,000 persons. To carry these, there are the cable lines, the Elevated Railroad, the suburban trains of the Illinois Central and the lake steamers, and it is believed that these will be sufficient without any additional provision. Including the number which will be brought by various vehicles and will come to the ground on foot, it is estimated that somewhat over 100,000 passengers per hour can be carried to or from the grounds without dangerous crowding of trains or cars.

THE number of passengers carried by the city lines in New York during the week of the Columbus celebration exceeded anything on record in that city. Every means of transportation was worked to its fullest capacity for at least three days of the week. On Wednesday, October 12, the Elevated roads carried 1,075,000 passengers, or more than twice the usual number. The emergency was met as well as might have been expected; but the dangerous crowding and many delays showed more plainly than ever the need of additional lines, either above or below the surface.

IT is announced that work has actually been begun on the new Simplon tunnel, which will, when completed, be the longest tunnel in the world. It will extend from Brieg, in Switzerland, to Isella, in Italy, and its total length will be 12.4 miles. In this work all the machinery used will be of the most approved description, and all means will be used to facilitate the boring of the tunnel; but it is expected that from eight to nine years will be required for its construction.

THE steamer *City of Paris*, of the Inman Line, has again broken the record, having reached New York October 19 in 5 days, 14 hours and 24 minutes from Queenstown. This is 1 hour and 34 minutes less than the best time previously made, which was by the same ship, and 2 hours and 7 minutes less than the time made by the White Star steamer *Teutonic* some months ago. The total distance run on this voyage—2,782 knots—and the distances made daily were: First day, 448; second, 508; third, 503; fourth, 505; fifth, 530; sixth, 288. The average speed of the vessel for the whole trip was thus 20.7 knots an hour, and her average speed on the best day's run was 22.08 knots an hour. This exceeds any Transatlantic performance on record, and shows really an extraordinary high sustained speed.

The *City of Paris* was built in 1889. She is 580 ft. long over all and 63¼ ft. beam. She has twin screws, each driven by a triple-expansion engine. The screws are three-bladed and are 20 ft. in diameter. It may be added that her average coal consumption on this trip was about 320 tons per day.

THE New York State Canal Convention met in Buffalo October 19, with a larger attendance than had been expected. A number of prominent persons were present, and the result of the meeting cannot fail to encourage those who are working for the support and improvement of the canals.

THE importance of good roads to the railroads is well urged by Colonel Pope, in a letter which is published on another page. While the road question affects all of us directly or indirectly, the railroads have, perhaps, the largest pecuniary interest directly involved, and their influence can do much to help on the agitation of the road question. The highway roads are their feeders, and the difference between easy and difficult access to a railroad station may have an important influence on its receipts.

BIG LOCOMOTIVE WHEELS.

THERE has been an endless discussion, ever since locomotives were first introduced, with reference to the size of their driving-wheels. Doubtless Stephenson and Ericsson and Hackworth at the time of the famous trial on the Liverpool & Manchester Railway, in 1829, discussed this subject as earnestly then as it is talked over now by different conditions of railroad men the world over. Practice, especially for fast passenger service, vacillates between driving-wheels of large and of small size. On another page we give an engraving of engine No. 870 of the New York Central & Hudson River Railroad, to which Mr. Buchanan has applied wheels 7 ft. ½ in. in diameter, the largest which are now used in this country. We also give engravings of the engine *Cornwall*, which is still running on the London & Northwestern, and has wheels 8 ft. 6 in. diameter, the largest which are now in use anywhere. The publication of the latter engravings in an English paper has called out some correspondence, from which it appears that the biggest driving-wheels that were ever used were employed on an engine called the *Hurricane*, built by the Messrs. Hawthorne for the Great Western Railway. This engine, it is reported, was a failure. So far as we now know there is no drawing or engraving of it extant.

From the illustration of the New York Central engine it will be seen that the boiler is so high that the chimney had to be shortened to almost dwarf proportions. This height of the boiler is due not entirely to the size of the wheels, but chiefly to the fact that the fire-box is placed

on top of the frames. Of course with large wheels the frames will be higher than they would be if the wheels were smaller, but in order to get sufficient depth to the fire-box the boiler must be placed at a considerable height above the frames. To get over the difficulty of raising the boiler and other parts of the engine when large wheels are used, a variety of expedients have been resorted to. From the engravings of the Northwestern engine *Cornwall*, on another page, it will be seen that when it was first built the boiler was placed *below* the driving-axle. This plan has been proposed by a number of inventors, but has never been successful.

In discussing this subject, Mr. D. K. Clark, in his "Railway Machinery," published in 1855, says:

> After all that had been done by Stephenson and others, to turn out an engine to suit the common gauge, which should combine the three desiderata, power, speed, and stability, it was obvious that a low center of gravity and a high driving-wheel were antagonistic elements, and they were assumed to be incompatible. The gauge could not be increased; engineers had, therefore, to find their additional power longitudinally and upward; to gain high speeds, they assumed a high wheel, and a high wheel required a high boiler. To exert power they adopted large cylinders; and to obtain power, they applied long boilers. Mr. T. R. Crampton has the merit of having solved the problem in all its fullness, of combining a low center of gravity with a large wheel and a powerful boiler. He conceived the idea of an extreme driving-axle, removing it from under the boiler, and placing it in the rear of the fire-box. This stumbling-block being removed, he lowered the boiler to just clear the axles of the carrying-wheels, removed all the machinery to the outside, enlarged the fire-box, and rendered every part accessible. Great freedom in every respect was thus gained, and unwonted facilities were afforded for properly proportioning the engine.

The first engine of this kind that was built had wheels 7 ft. diameter and cylinders 16×20 in. Another one, built for the London & Northwestern Railway, had wheels 8 ft. diameter and cylinders 18×20 in., and a third with wheels of the same diameter, but with cylinders 18×24 in. and 2,290 ft. of heating surface, and a total rigid wheel-base of 18½ ft. Of this engine Mr. Clark said:

> This splendid monster worked the express trains between London and Wolverton for some time, and on one occasion conveyed a train of 40 carriages within time, more than work for three ordinary engines; it was, however, laid aside on account of its excessive weight, aggravated, no doubt, by the great distance of end centers, which quickly told upon the maintenance of the permanent way.

It is said that the Norrises, who first started in business in Schenectady, built an engine there with a single pair of wheels 8 ft. in diameter, and about the year 1849, in Philadelphia, they built a number of locomotives similar to Crampton's for the Camden & Amboy Railroad. Some of these had wheels 7 ft. in diameter. The top of the fire-box was made to slope downward, and the driving-axle was placed over it. A large number of Crampton engines were built for French railroads, some of which are probably still in use.

From what we have quoted it will be seen that so eminent an authority as Mr. Clark was of the opinion that Crampton had solved the problem of high-speed engines, but the former had in his mind the bugbear of a high center of gravity, the objections to and difficulties of which recent experience has shown are purely imaginary.

Some builders made indentations for the driving-axle in the under-side of the boiler, so as to permit it to be lowered down over the axle. It was also proposed to put a transverse tube through the boiler to receive the axle, although it is not known that this plan was ever put into actual practice.

In 1849 Ross Winans, of Baltimore, built an engine called the *Carroll of Carrollton*, which was tried on the Boston & Worcester Railroad, which is now the eastern end of the Boston & Albany line. This had a single pair of wheels about 7 ft. in diameter, which were located near the middle of the engine, with a four-wheeled truck under the smoke-box and another one behind under the fire-box. To get the required adhesion of the driving-wheels, vertical steam-cylinders and pistons were placed over the driving-boxes, by which more of the weight of the engine could be thrown on the driving-wheels than they would otherwise carry. The engine was a failure and was run for only a short time, and some years after was cut up and sold for scrap.

About 1851 Seth Wilmarth, of Boston, built two engines for the Hudson River Railroad with four coupled wheels 7 ft. in diameter, with $16\frac{1}{2} \times 22$ in. cylinders. Other engines with 6 ft. 6 in. wheels were also used on that line about this time. The weight of these engines was only about 22 tons (of 2,000 lbs.). They had very small boilers and fire-boxes and burned wood for fuel.

On the Pennsylvania Railroad, what were known as Class K locomotives, with 6 ft. 6 in. wheels, were built, but owing to insufficient boiler capacity were not successful in the service for which they were intended—that is, heavy and fast passenger traffic.

About 10 years ago the Baldwin Locomotive Works built an engine with a single pair of driving-wheels 6 ft. 6 in. diameter, and a wide fire-box, which was partly carried on a pair of trailing wheels under it. It was tried on several roads and was afterward bought by Mr. Eames, the inventor of the Eames brake, and was taken to England to show Englishmen what a Yankee locomotive could do. This was unfortunate for the reputation of our engines and also for Mr. Eames. The engine was not suited for English roads, and was finally sold and broken up.

Geared locomotives of various kinds have often been used, but, excepting for slow speeds, have not met with favor. An example of these was the Fontaine engine, built a dozen or more years ago. This had frictional gearing, and attracted a great deal of attention at the time it was brought out, but was ultimately submerged in the oblivion of the scrap-heap.

From this brief and imperfect review of the use of large driving-wheels in this country, it will be seen that to a great extent it is a history of failure. None of the engines with wheels over 6 ft. in diameter survived but a short time. In Europe, however, wheels 6, 7 and 8 ft. are very common, the larger sizes being employed mostly on what are called single engines—that is, engines with one pair of driving-wheels. Such wheels have been used there for a long time, apparently with great success.

The latest examples of the use of large wheels here is Mr. Buchanan's locomotive with 7 ft. 0¾ in. coupled wheels, which is illustrated on another page, and which is making a very brilliant record for itself, and is proving a great success. The Pennsylvania Railroad Company have also just completed a compound locomotive with drivers of the same size, but of the performance of this we have, as yet, no report.

The reasons for the failure of locomotives with large wheels here, and their success in Europe, and finally of their triumph here, are interesting. It may be said, in the

first place, that for heavy trains a locomotive with a single pair of driving-wheels is necessarily deficient in adhesion. For that reason, too, it is unsuited for traffic involving frequent stops. It might be thought, that if the trains are light, such engines could be used even if the stops are frequent; but any one familiar with railroad practice knows that an engine is liable to slip with the lightest train, or without any train, if started suddenly. To start quickly, if a locomotive has sufficient cylinder and steam capacity it can always utilize all its adhesion, no matter how great that may be. If it is little it must start slowly; if great it can start quicker. Consequently for traffic requiring many stops much adhesion is needed. If there are few stops and the trains and grades are light, but little adhesion will suffice, and large wheels are then a great help in making fast time; but up to the present time we have had comparatively little or no traffic of that kind in this country. In the few cases in which light trains were run, with few stops, the engines employed had to be capable also of taking heavy trains, or those which stopped often. For such traffic, as before remarked, single engines are not suited, and it is because of their unadaptability to various kinds of traffic that single engines have not been used in this country.

If large coupled wheels are used, they and their connections will necessarily be heavier than they would be if they were of smaller size. To get the requisite tractive capacity, the cylinders must be increased in proportion to the wheels. This means more weight in all the connected parts. If the tractive force is great and the speed high, the consumption of steam will be in proportion. This will require great boiler capacity with a corresponding weight of that organ. Now the engines with 7 ft. coupled wheels which were used on the Hudson River road about 40 years ago weighed only about 22 tons, or 44,000 lbs. That weight could not be exceeded on the permanent way which was then used, and it was impossible to make the boiler large enough without exceeding the limits of load on the rails. If we compare this weight with that of Mr. Buchanan's new engine, which is nearly three times as heavy, it will be seen that with the latter it is possible to have the requisite cylinder and boiler capacity, and thus make an efficient all-round engine, or one which will not only haul a light train at a high rate of speed, but will, if required, and as has been shown by the performance of this engine, take a heavy train as well, at a moderate speed, and is capable of making as many stops as may be required without losing time. The era of big locomotive-wheels has arrived, and we may expect a gradual increase in their size hereafter.

THE FIRST LOCOMOTIVE IN AMERICA.

SOME of our readers may remember that in the account of the life of the late Horatio Allen, which was published in the JOURNAL of February and March, 1890, it was stated that he went to England in the winter of 1828 and 1829 and there made a contract with Messrs. Foster, Rastrick & Company, of Stourbridge, for *one* locomotive for the Delaware & Hudson Canal Company, and made another contract with the Messrs. Stephenson, of Newcastle, for *two* more locomotives. After the death of Mr. Allen, and after that account of his life was written, an examination of some old correspondence on file in the office of the Delaware & Hudson Canal Company has shown conclusively that *three* engines were built by the first-mentioned firm—among which was the well-known *Stourbridge Lion*—and *one*, the *America*, by the Messrs. Stephenson. The correspondence referred to also showed that the locomotive built by the Stephensons arrived in New York, on board the ship *Columbia*, about the middle of January, 1829. The first one of these, built by Foster, Rastrick & Company, arrived on board the *John Jay*, May 13 of the same year; the second one on the ship *Splendid* about the middle of August, and the last one on September 17 on the *John Jay*. It will thus be seen that the Stephenson machine was the first locomotive in this country, although it was not the first to run on a railroad. The singular part of its history is that it is not known what ever became of it. All trace of it has been lost as completely as though it had been cast into the sea. Being the first locomotive in this country, especial interest attaches to it, and our readers will be interested in the following data, for which we are indebted to Mr. Clement E. Stretton, of Leicester, England, who says: "I have just unearthed the official details of the engine named *America*, of which find copy enclosed."

DESCRIPTION OF LOCOMOTIVE ENGINE "AMERICA," BUILT BY R. STEPHENSON & COMPANY, FOR THE DELAWARE & HUDSON CANAL COMPANY, TO THE ORDER OF MR. HORATIO ALLEN, 1828, AND NO. 12 IN THE BOOKS OF THE MAKERS.

Diameter of boiler	4 ft. 1 in.
Length " "	9 " 6 "
Dimensions of fire-place	4 ft. × 3 ft.
Diameter of steam cylinder	9 in.
Length of stroke	2 ft. 0 "
Size of chimney	1 " 8 " (?)
" " hot-water pump	$1\frac{1}{2}$"
Stroke " "	2 " 0 "
Wheels (wood), diameter	4 " 0 "
Number of wheels	4
Angle of cylinder to the horizontal	33°
Size of tubes	1 ft. 7 in.
Number of fire tubes	2

Tubes were straight.

NEW PUBLICATIONS.

GEOLOGICAL SURVEY OF NEW JERSEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR 1891. Professor John C. Smock, State Geologist. State Printers, Trenton.

The Geological Survey of New Jersey, under the late Professor Cook, was noted for its thorough and excellent work and the high character of its publications; and under his successor its reputation seems to be fully maintained. The geological and geodetic surveys of the State are now nearly complete, and form a work which has been and continues to be of very great service to its people.

The present report, after some 35 pages devoted to a general account of the work done on the surveys during the year, contains a very interesting paper on the drift formations of the State and the evidences and remains of glacial action, which are abundant over a large part of its surface.

The larger part of the volume is taken up by two studies in Economic Geology. The first relates to the Oak and Pine belts of Southern New Jersey, and contains some excellent suggestions as to the best methods of utilizing them, especially with reference to the preservation of a proper and useful area of timber. The second is in relation to Water Supply and Water Power. With the growing population of the northern part of the State and its increasing concentration in towns and cities, the question of Water Supply is a very important one, and the Survey has been engaged in a careful examination of the streams and rivers, their sources of supply, flow, quality of water and other essential points. The questions of Water

Power and Drainage form an essential part of this study and have received much attention.

The report is illustrated by a number of plates and diagrams, and is accompanied by a map of the State, which is itself a most excellent specimen of work.

REPORT OF THE PROCEEDINGS OF THE TWENTY-SIXTH ANNUAL CONVENTION OF THE MASTER CAR-BUILDERS' ASSOCIATION, HELD AT SARATOGA, N. Y., JUNE 15, 16 AND 17, 1892, Chicago; published for the Association, John W. Cloud. Secretary.

The report of this Association always contains some reports and discussions of interest, and the present volume is no exception to the rule. Perhaps the most notable is the report or the Committee on Standards and the discussion following it, while the reports on Wheels and on Air Brake Instructions may also be mentioned. The report is printed and prepared with the usual care.

POOR'S DIRECTORY OF RAILWAY OFFICIALS. *Seventh Annual Number.* 1892, New York; H. V. & H. W. Poor.

This directory, the companion of *Poor's Manual*, has been the accepted standard so long that it calls for little especial remark. Some additions have been made to the book this year-notably an alphabetical index of directors of corporations. The information given about street railroad companies has been enlarged and made more satisfactory in form, and some general statements in relation to their operations are given in the preface.

Like the *Manual*, this *Directory* is indispensable to all who have dealings with railroad companies and their officers.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITH SONIAN INSTITUTION. Government Printing Office, Washington.

The annual report of the Board of Regents contains the usual information concerning the workings of the Smithsonian Institution, which does not call for special comment. It contains also a number of excellent short papers giving brief accounts of scientific discovery in particular directions; these are by various authors, and most of them are interesting summaries of scientific progress. The paper on Astronomy is accompanied by a list of new publications on that subject, both in English and other languages.

GUATEMALA. Washington; published by the Bureau of the American Republics, William E. Curtis, Director.

This book—Bulletin No. 32 of the Bureau of the American Republics—is descriptive of the largest of the Central American States, a country presenting many interesting and attractive features. It is rich in natural resources of various kinds which have not been developed, chiefly because of the sparse population and the lack of labor. When this is supplied, Guatemala has great possibilities, and it may in the future become one of the wealthiest countries on this continent. Meantime it needs capital and enterprise, which the United States might supply, and perhaps will. To interest us in the country and to draw attention to its capabilities is the object of the Bureau of the American Republics in this book.

COLOMBIA. *Bulletin No. 33 of the Bureau of the American Republics.* Issued by the Bureau, W. E. Curtis, Director, Washington, D. C.

This is another of the excellent monographs on the Spanish American countries issued by the Bureau of the American Republics, in pursuance of its purpose of promoting knowledge of and intercourse with those countries. In general arrangement and design it is the same as those which have preceded it, containing a brief historical sketch, general accounts of the economic and political geography, of the political institutions, of the industries of the country, and much commercial information, including accounts of the tariff, port regulations and similar matters, and a commercial directory. Colombia is a very interesting country, with great possibilities of future development, and this number of the series is worth careful reading.

THE ENGINEER'S EPITOME: A COLLECTION OF FIGURES, FACTS AND FORMULÆ FOR ENGINEERS. By N. J. Smith. Boston, Mass.; the Mason Regulator Company. Price, 50 cents.

This is No. 3 of a series of books issued by the Mason Regulator Company, of Boston, for the information of engineers. It contains 135 pages and is of convenient size for the pocket. It is intended as a book of reference, and contains a variety of rules and other information useful for those who have charge of an engine. After some preliminary general instruction on arithmetic, etc., it has chapters on Steam; Boilers; Chimneys; Power of Engines; Condensers; Valves; Governors; Belts; Pumps; and several useful tables. The concluding pages have descriptions of the reducing and regulating valves, governors and other devices made by the Mason Company, but this advertising part is very modest in its dimensions and is well and carefully written.

The rules and formulæ are generally those which have been approved by practical use, and the book is a very handy companion for engineers, and indeed for all who have to do with stationary engines and boilers.

FIFTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. DECEMBER 1, 1891. Government Printing Office, Washington.

The present report of the Interstate Commission gives a careful statement of the work done during the past year, and of the variety of subjects brought before it for decision. It shows the increasing volume of the work and the manner in which it has been done. It also notes the defects in the existing law, and makes several suggestions for its improvement, especially in the direction of enforcing compliance with its provisions.

Among other important questions which have engaged the time of the Commission were Uniform Classification of Freight; Use of Shippers' Cars; Through Routes and Rates; Bills of Lading; Special Rates. These have received special attention, in addition to that required by the regular work of the office.

The Convention or Conference of railroad commissioners is referred to, and some stress laid upon the advantages which may be secured from these meetings, and especially on the work done in the direction of securing the adoption of safety appliances.

The statistical work done under the direction of the Commission has heretofore been noticed from the advance sheets furnished.

AN INTRODUCTION TO GEODETIC SURVEYING. By Professor Mansfield Merriman, Ph.D. New York; John Wiley & Sons. Price, $2.

The science of Geodesy in its several branches should have an especial attraction for students, though it is, perhaps, less known and studied than it should be. Most of the works on the subject are too large for the ordinary student and engineer, whose time is fully occupied with his daily work. The author's intention in this book is perhaps best explained by himself:

In the first part of this book several lectures on the Figure of the Earth, prepared as an introduction to a course of study in Geodesy, are republished. In the second part is given a condensed presentation of the fundamental principles and rules of the Method of Least Squares, written especially for students, surveyors, and engineers who are unable to spare the time required for the perusal of the larger books on the subject. The theoretical discussions have necessarily been omitted, but

the fundamental ideas concerning adjustments, weights of observations, and probable error are fully explained, so that computations may be made intelligently and not blindly. In the third part is presented a synopsis of the methods and computations required in the field work of precise triangulation, particularly in secondary geodetic work.

Care has been taken to illustrate the rules and formulas by numerical examples, and to give problems exemplifying their applications. Thus the three parts of the book form an introduction, both theoretical and practical, to the science of Geodesy, and especially to Geodetic Surveying.

Professor Merriman has the great merit of a concise and clear style, and in all his books he has shown what many scientific writers lack, the ability to make his meaning clear to the reader, and to impart knowledge without overloading his work with explanations. The present book is no exception, and one may turn with confidence to its pages, sure that what he seeks will be told in a way that must be comprehended by any one able to read and follow a serious train of mathematical argument.

The book is illustrated by many diagrams which are necessary to make some of the explanations clear. The student of Geodesy will find it an excellent opening for his course, and the engineer need not neglect its pages.

DIE NORDAMERIKANISCHEN EISENBAHNEN IN TECHNISCHER BEZIEHUNG. THE RAILROADS OF NORTH AMERICA IN THEIR TECHNICAL RELATIONS. *A Report of Studies Undertaken by Direction of the Ministry of Public Works.* By A. von Borries, State Railroad Inspector, and Thomas Büte, State Railroad Director. C. W. Kreidel, Publisher, Wiesbaden, Germany.

Herr A. von Borries, who is well known by reputation as a railroad engineer in this country as well as in Germany, and Herr Thomas Büte, who is a Director of the Prussian State Railroads, last year made an official visit to this country, inspecting the methods of operation and management of some of the important lines, including the Pennsylvania, the Reading, the New York Central, the Chicago & Northwestern, and others, and they also visited some of our large manufacturing establishments. The result of this visit now appears in an elaborate report made to the Ministry of Public Works presenting the result of their observations. The *Report* makes a volume of 282 large pages, appended to which are 55 plates evidently made from drawings and photographs obtained in this country.

The scope of the report will be seen from the general titles of the different parts, which include Organization and Management; Signals; Locomotive Building; Car Building; Locomotive and Car Service; Repair Shops; Mechanical Superintendence; Brakes; Car Heating; Lubrication; Railroad Superstructure; Stations and General Conduct of Business. These commissioners from the German Government were evidently diligent in taking notes; and while their observations were, of course, chiefly made with a view to the instruction and benefit of the German railroad management, many of them might be read with profit by American managers. As to the several parts of the report, it may be said that in a general way the more technical portions in relation to construction and design have been written by Herr von Borries, and the observations as to management and the conduct of business by Herr Büte. The engravings, as before noted, have evidently been made from photographs and drawings, including a number of different types of locomotives and cars for both freight and passenger service, several yards and stations, some repair shops, and a number of tools, chiefly for wood working, that class of machinery having apparently presented more interest and novelty to the commissioners than the iron-working tools. Traffic as well as technical management received their attention, and much is said in the report in relation to the handling of both freight and passenger business, rates, and even the management of the sleeping, parlor and dining car service.

The report, in fact, is a good specimen of the practical application of German thoroughness of observation and method. It may be added that the brief reading which has thus far been possible seems to show that American methods were in general favorably regarded by the writers, although some occasion has been found for criticism.

MECHANICAL DRAWING. *Progressive Exercises and Practical Hints.* By Charles W. MacCord, Professor of Mechanical Drawing in the Stevens Institute of Technology, Hoboken, N. J. New York; John Wiley & Co.

This book consists of two parts: the first, which is new, on Mechanical Drawing, and the last, Practical Hints for Draftsmen, which was first published in 1887; the two being now issued in one volume. The first chapter gives elementary exercises in drawing, straight lines and circles. It contains many hints for the young draftsman which are excellent in their way; but there seems to be a lack of practical illustrations and applications of those principles. It is true that the Author says that those for whom he is writing "are presumed to have gained, from other sources, an acquaintance with such geometrical principles as may be made use of in the course of the work," but even a student well up in geometry who should take this first chapter for his guide in learning mechanical drawing would, it is thought, be a good deal puzzled to know how to proceed. In beginning to learn this art the first thing is to get the required materials and instruments, which is usually a matter of great interest and importance to the beginner, and generally in doing this he makes some sad mistakes, and wastes money which he cannot easily spare. In the book before us the description of the drawing instruments is given in the last chapter instead of the first. If the student has wit enough to begin his course of study by reading the end of the book first, and has provided himself with the requisite tools, and should take the first chapter as his guide, he would probably be sadly puzzled to know just what to do with them, even though he was acquainted with geometrical principles. A variety of directions are given with reference to penciling, inking, laying off measurements, thickness and junction of lines, etc., all excellent in their way. The first specific instruction to the student how to draw anything is that on page 12, on which he is told how to inscribe three circles in another circle all tangent to each other and the same number in a triangle—rather difficult tasks for a beginner who has no knowledge or experience in using drawing instruments. The succeeding problems are six and seven circles inscribed in a triangle and in a circle, complicated star patterns inscribed in a circle, interlaced work, circles tangent and eccentric to each other—"confined tangencies," ovals, etc. The directions to the learner how to proceed in doing this work are brief and quite inadequate for one who is without any knowledge of the subject. Doubtless under the eye of a teacher he would get along without much difficulty; but this ought not to be needed in a course of "Progressive Exercises."

The title of the second chapter is Exercises in the Drawing of Non-circular Curves. The progress in this, as in the first one, is at times too steep. To ask a beginner, in his second lesson, to draw "epitrochoid, Archimedian spiral, and logarithmic spiral" curves is establishing a grade for the learner too steep for the adhesion of his comprehension.

Chapters III and IV are on the principles of projection, and they are excellent in their way, but are introduced too early in the course. If some of the practical examples in the first part of the second portion of the book had been introduced before the principles of projection were explained, it would have made the ascent for the learner much easier.

Chapter V is on the Helix and its Application in the Drawing of Screws, a subject which has very little practical value

to a draftsman, and which might with advantage have been relegated to a later position. The sixth chapter is on Intersections and Development of Surfaces, which is very clear and useful. The seventh is on Isometrical Drawing, Cavalier Projection, and Pseudo-Perspective. The eighth and last chapter is on the Spur-wheel and the Bevel-wheel in Inclined Positions, Construction of the Close-Fitting Worm and Wheel, Construction of the Screw-Propeller, Standard Sectioning, etc.

The book is full of valuable hints and suggestions made by an accomplished draftsman of extended experience who knows his subject thoroughly, and therefore they have a corresponding value. The book is admirably printed and illustrated, but is badly arranged. Much that is in the first part should be last, and *vice versa*. Its progress should be by easier steps, and it would be much improved by simply arranging the chapters in different order. The old part has been spliced on to the new, whereas it ought to have been incorporated with it.

CURRENT READING.

In the November number of Harper's Magazine the New Growth of St. Louis is the subject of a striking article. Another paper treats of a now almost forgotten historical episode, the struggle for the possession of Oregon ; while a third treats of the designing and supervision—the architects' work—on the buildings of the Columbian Exposition. The number is particularly strong in fiction and in its illustration.

In its discussion of graver topics the Arena does not entirely neglect amusement, and in its October number gave an appreciative and excellently illustrated article on Sothern, who is undoubtedly one of our best comedy actors. This will be followed at intervals by similar papers. This mixture of entertainment is good ; but the great strength of this magazine continues to be in its absolutely free and fearless discussion. No other periodical approaches it in this respect, and it has acquired a position for itself which gives it a wide constituency among thinking people. No one who wants to know the best of current thought and discussion on the problems of modern life can neglect it.

Some of the best of current articles from the English reviews are given in the Eclectic Magazine for October, and even a greater variety than usual is there presented.

Chicago's Part in the World's Fair ; the Sponges of the Florida Reef ; French Art, and Racing in Australia, are among the subjects treated in Scribner's Magazine for November. Several very interesting literary papers are also among its contents, including an account of the Journal kept by Victor Hugo during his long exile from France.

In the number of Harper's Weekly for October 5 there are several illustrations of the buildings at the Columbian Exposition. Sir C. W. Dilke has an excellent article on London, and there is an illustrated account of the Columbus celebration at Genoa.

In the September number of Minerals there are articles on Aluminum ; Bismuth Mining in Australia ; Indian Diamond Fields ; Mining Exhibits at the World's Fair, and a number of others of interest.

Corsica ; the Nile and its Floods ; the Androscoggin Valley ; the Arctic ; Irrigation in Ceylon ; Columbus and his Times, are among the subjects treated in Goldthwaite's Geographical Magazine for September. This does not complete the list, as there are also a number of shorter articles on different topics.

The latest number of Good Roads has articles on the Cost of Bad Roads, by Professor Ira O. Baker ; on Ways and Means ; on National Aid to Road-Building ; on Sidewalk Specifications ; and the conclusion of Editor Potter's papers on Dirt Roads and Gravel Roads. It is a good number and ought to be read everywhere.

In the October number of the Engineering Magazine there are articles on the Industrial Development of the South ; the Regulation of the Professions ; Bridge Building in America ; Industrial Decadence in Germany ; the Copper Region of Michigan ; Guarding against Cholera ; Measurement of Electricity ; the Phosphate Industry of Florida ; Interior Fireproof Construction ; Reciprocity with Canada ; Colonel E. C. Smeed and his Work ; and the usual special editorial departments, the latter being very good of their kind.

The last number of the Proceedings of the United States Naval Institute is given up entirely to the publication of six lectures on First Aid to the Injured and Transportation of the Wounded, by Dr. Henry G. Beyer. These lectures were recently delivered to the naval cadets at Annapolis.

The military article in Outing for October is on the New Jersey National Guard, and is by Lieutenant W. H. C. Bowen, U. S. A. A number of articles on shooting, athletics, the bicycle and travel, with some very good illustrations, make a very attractive number.

In the Popular Science Monthly for November Dr. Wesley Mills treats of the Natural or Scientific Method in Education. Among the other articles are papers on Economical Trees, by F. L. Sargent ; on the Mixed Race of India, by Sara J. Duncan ; on the Scientific Societies of Italy, by Dr. W. J. Cahall ; on Problems of Comparative Psychology, by Dr. Jastrow, and a number of shorter ones of interest.

BOOKS RECEIVED.

Selected Papers of the Institution of Civil Engineers. London, England ; published by the Institution.

A Ready Reference for Engineers and Steam Users. By James B. Stanwood, M.E. Cincinnati, O. ; Houston, Stanwood & Gamble. Price, 25 cents.

Report on the Internal Commerce of the United States for the Year 1891. *Part II. of Commerce and Navigation : The Commerce of the Great Lakes, the Mississippi River and its Tributaries.* S. G. Brock, Chief of the Bureau of Statistics, Treasury Department. Washington, D. C.; Government Printing Office.

Massachusetts Institute of Technology : Department of Engineering Prospectus for 1892–93. Boston ; published by the Institute.

Chairman's Report of the Operations of the Melbourne Tramways Trust from October 26, 1888, *to August* 19, 1892. Melbourne, Victoria ; printed for the Tramways Trust.

Journal of the New England Water Works Association : September, 1892. New London, Conn.; published for the Association.

TRADE CATALOGUES.

Partial List of Purchasers of Reynolds' Corliss Engines. The Edward P. Allis Company (Reliance Works), Milwaukee, Wis.

This pamphlet contains a long list of engines of all sizes and built for all sorts of purposes. It shows that the engines of the Allis Company are found in all parts of the country, East as well as West. The largest engines on the list are a compound condensing pumping engine for the Chapin Mining Company at Iron Mountain, Mich., which has cylinders 50 and 100 × 120 in., and a triple-expansion pumping engine for Omaha, which has cylinders 40, 70 and 104 × 60 in. There

are a large number of compound and triple-expansion engines in the list, and at least one quadruple-expansion, which has cylinders 24, 36, 52½ and 64½ × 72 in., and was built for the Warren Manufacturing Company at Warren, R. I.

Light Locomotives. H. K. Porter & Company, Pittsburgh, Pa. Seventh Edition, 1892.

The use of small locomotives, not only for ordinary railroad purposes, but also for moving material in furnaces and factories, for mining purposes, for contractors on earthwork, for street railroads, and in many other places, has been gradually extending in this country, and they are now found at work in many places where the advantages of steam over animal power have been realized.

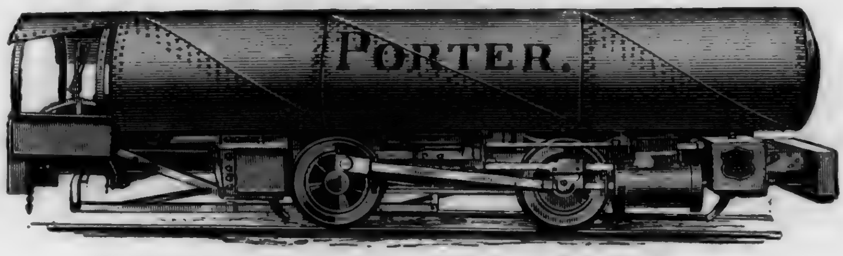
While all locomotive builders are occasionally called upon to supply light locomotives, there is at least one establishment which devotes its time entirely to the building of this class of engines. The shops of H. K. Porter & Company, in Pittsburgh, have for a number of years been engaged in this work, and their long experience naturally gives them many advantages. The latest edition of the catalogue issued by the firm shows a great variety of types and classes of engines for general purposes and for special varieties of work. How great this variety is can hardly be appreciated without an inspection of the catalogue itself.

Among the different kinds of engines illustrated are locomotives for passenger and freight service on narrow-gauge and other light railroads; motors for street railroad service; engines for shifting and yard work on railroads and in factory yards; for coke ovens and blast furnaces; for logging railroads; for contractors' temporary lines; for plantation lines; for moving blooms and ingots in steel works and rolling mills; and for a number of other purposes, including underground work in mines.

As an illustration of the class of work engines of this kind may be called upon to do, the cut given herewith shows a six-wheel engine on a logging railroad, on the Pacific Coast, with a train of redwood logs. In this case the road-bed is comparatively good, consisting of steel rails laid on stringers which are held together by cross-ties. In many cases the road-bed of this class of lines is of the roughest description, and the engine is called upon to do heavy work under very unfavorable conditions. For this the builder must be prepared and make allowance in his designs.

An engine of the class shown, with 9 × 14-in. cylinders, works over short grades as high as 212 ft. to the mile, frequently hauling 10 cars weighing 62 tons in all.

A recent addition to the catalogue of this firm is compressed-air locomotives for mining purposes, two of which are shown herewith. It will be seen that the running-gear is similar to that of a steam locomotive, but the boiler is replaced by the air reservoir. This may be a single cylinder, as shown in the first illustration, or twin cylinders, as in the second, according to the dimensions permitted by the size of the mine galleries. They can frequently be used in mines where from local causes a steam locomotive could not. In these engines the air reservoir is made to carry pressures as high as 500 lbs.



COMPRESSED AIR MINING LOCOMOTIVE.

COMPRESSED AIR MINING LOCOMOTIVE.

It may be added that while the heaviest engine shown in this catalogue has 14 × 24-in. cylinders and corresponding weight and general dimensions, there are locomotives included, for plantation and mill purposes, which have 5 × 10-in. cylinders, 22-in. driving-wheels, and weigh only 8,000 lbs. in working order. Such engines are doing good and effective work, one of them being on record as having hauled a train weighing 54 tons, without difficulty.

This catalogue is an interesting study, as it shows a great variety of designs for special purposes, in a field where there is probably much more diversity of requirements than is found in locomotives of the sizes used in ordinary traffic.

LOGGING LOCOMOTIVE, WITH TRAIN OF REDWOOD LOGS.

The Butler Drawbar Attachment Company's Illustrated Catalogue and Price-list. Cleveland, O.

This pamphlet contains a very handsomely printed and illustrated description of the various devices made by the Butler Drawbar Attachment Company. The use of these is rapidly extending, a fact which needs no explanation after looking over this catalogue, since the usefulness of the attachments is at once apparent from the descriptions. Every one who is interested in building and running cars ought to see this pamphlet.

Indicators, Planimeters, Pantographs, Speed Counters. The Thomson Hydraulic Company, Temple Court, New York.

This company has recently purchased the business and plant of the Engineers' Instrument Company of New York, and will continue the manufacture of the instruments named above, as an adjunct to its own chief business, which is the making of water-meters. The catalogue shows the instruments made, with some notes on their use.

Catalogue and Price-list of the Sweetland Chuck, the Standard Chuck and the Porter Belt-clamp. The Hoggson & Pettis Manufacturing Company, New Haven, Conn.

This pamphlet contains illustrated descriptions of the devices mentioned and of several others which are manufactured by the Hoggson & Pettis Company. Most of them are already well known and approved by continued use in machine work. The Sweetland chuck especially has a wide range of service and is in use in many places.

The Reynolds-Corliss Engine. Catalogue of the E. P. Allis Company, Milwaukee, Wis. New Edition, 1892. *Illustrated.*

SOME CURRENT NOTES.

AT the naval parade in the New York Columbus celebration the representation of war-ships was not very large, though the ships present were good of their kind. Italy sent the cruiser *Giovanni Bausan ;* Spain the cruiser *Infanta Isabel*, and France the cruiser *Aréthuse* and the dispatch-boat *Hussard*. None of these were ships of the largest class. Our own Navy was represented by the cruisers *Philadelphia* and *Atlanta*, the monitor *Miantonomoh*, the dynamite cruiser *Vesuvius*, the dispatch-boat *Dolphin*, and the torpedo-boat *Cushing*.

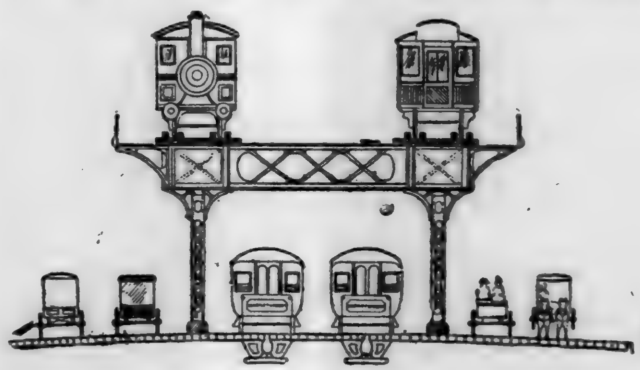
A VERY curious inquiry undertaken by some French scientists seems to show a certain relation between railroads and the average height of the people. From the statistics collected in connection with the conscription, to which all young men in France are subject, it appears that in certain communes and departments there has been a notable increase in the average height of the men in the last 30 years, or since the building of railroads in those departments. This is attributed to the fact that the railroads have offered better paying work to the people, both directly and indirectly, by the introduction of manufactures ; this has improved the condition of the people, who are now better housed and fed than formerly, and consequently grow to a greater height. The reasoning is carefully worked out, and the connection seems to be well established.

THE latest canal project in Europe is for a waterway to connect the Danube and the Oder. The proposed canal is to leave the Danube near Vienna, and to pass through Lower Austria, Moravia and Silesia to Oderburg. It would furnish cheap transportation for coal to Vienna, which is much needed by that city. The project includes branches through Bohemia to the Upper Elbe, and through Galicia to the Vistula, opening up an extensive system of navigation.

FROM a paper recently presented before the Statistical Society in Paris, it appears that there are in use in France 78,600 steam-engines, having a total of 5,360,000 H.P. From 1880–90 the increase amounted to 647,000 H.P., and since 1890 it has been 184,000 H.P. This statement applies to stationary engines only, and does not include the locomotives in use on the French railroads. In recent years the increase has been rapid, owing to the increase of manufactures and to the extension of railroads, making fuel cheaper and more easily procured than formerly.

THERE are reports that the Russian Trans-Caspian Railroad is to be extended beyond its present terminus, and that several branches are to be built. The growing commercial importance of the line may have something to do with this, but the ruling factor will be political. The Trans-Caspian is a great element in the Russian political power in Central Asia, and any new building will be done with a direct view to the extension of that power—and perhaps also to the advance on India which is sure to come sooner or later.

THE plans of the Quaker City Elevated Railroad Company for its line through Market Street in Philadelphia have been submitted. From the accompanying sketch,



PROPOSED ELEVATED RAILROAD IN PHILADELPHIA.

which shows a cross-section, it will be seen that the structure will bear a considerable resemblance to that of the Sixth Avenue line in New York. It will be somewhat heavier, but of the same general type. The motive power will be furnished by steam locomotives burning anthracite coal.

THE Altoona shops of the Pennsylvania Railroad have just turned out a heavy compound engine which will be tested on that road with a view to determining, if possible, what advantage may be secured by the double expansion. This engine—No. 1515—weighs 72½ tons ; it is of the two-cylinder type with cylinders 19½ in. and 31 in. × 28 in. The low-pressure cylinder is, we believe, the largest ever made for a locomotive. The boiler will carry a working pressure of 200 lbs. The ratio of the cylinders is 1 : 2.53. The driving-wheels are the largest ever made by this company, being 7 ft. in diameter. This engine will be put in service on the New York Division, on the fast trains between New York and Philadelphia.

THE Lehigh Valley Railroad will soon put into service 10 consolidation engines of the Vauclain four-cylinder type, which will have a thorough trial in heavy freight work. These engines are now being built by the Baldwin Locomotive Works ; they have cylinders 14 in. and 24 in. × 26 in., and driving-wheels 55½ in. in diameter. The crank-pins are of steel, and will all be bored and oil-tempered, as described in the JOURNAL some time ago.

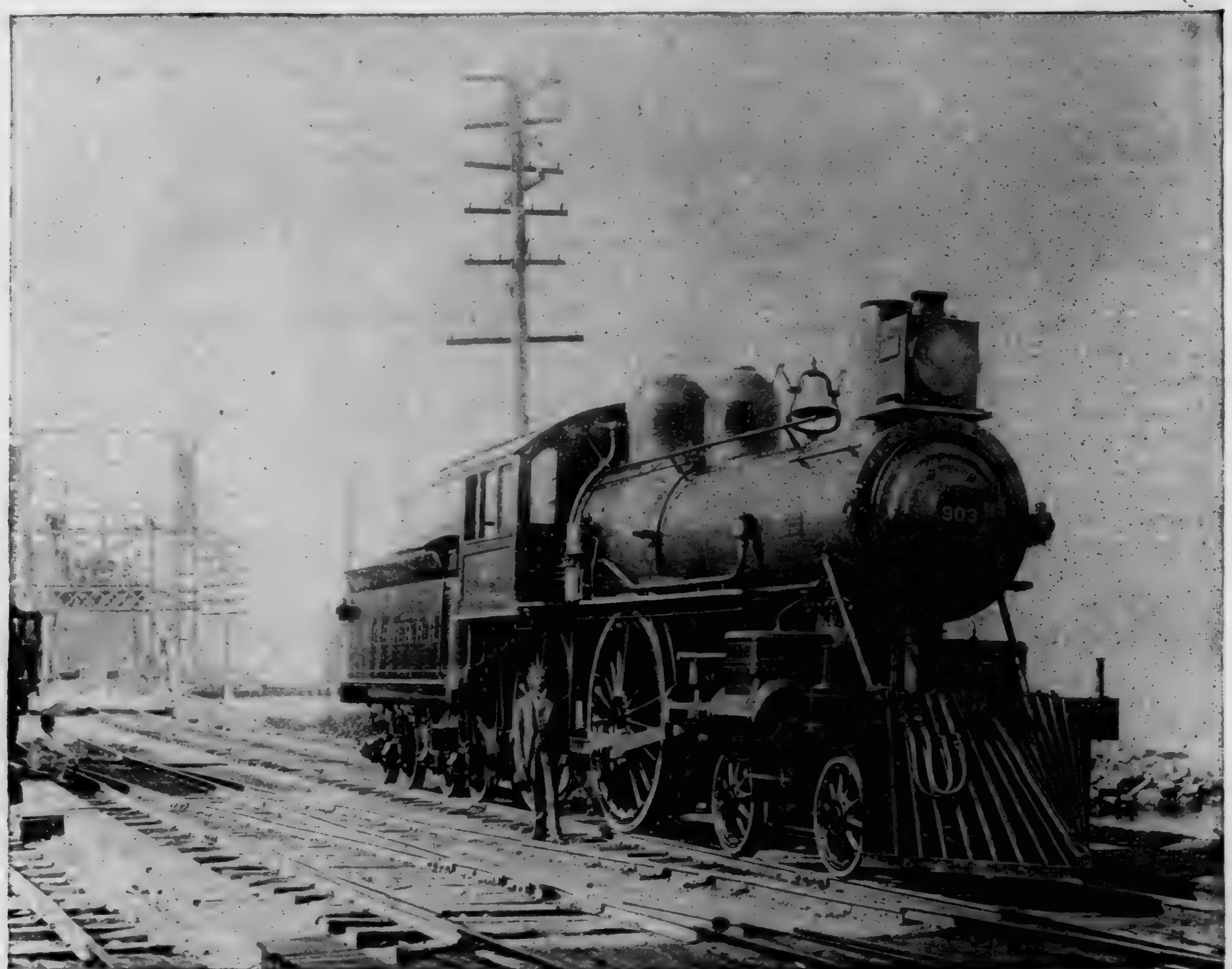
On October 1 the tables of the *American Manufacturer* show that there were 242 furnaces in blast, having a total weekly capacity of 161,558 tons of pig iron. This is a slight increase over the September report, the producing capacity having gained about 3 per cent. during the month. It is a considerable decrease—11 per cent.—from October of last year, however; but the rate of production was then extraordinary, many of the large bituminous and coke furnaces having just blown in after a long stop. The production this year has been much steadier and more uniform than in 1891.

At the new ship-yard of the Maryland Steel Company, in Baltimore, it is proposed to do away with launches by building ships in dry-docks, which can be flooded when a vessel is ready. This plan has been suggested before and occasionally used—notably with some of the large English battle-ships—but has never, we believe, been made a regular feature of a yard.

The report of the Railroad Commission of New South Wales for the year ending June 30 last shows that the Colony has 2,266 miles of railroad in operation. The general depression of business affected the roads, but their total earnings were about $15,536,000 gross and $5,965,000 net. The surplus remaining was sufficient to pay 3.58 per cent. on the capital invested in the construction of the roads. Like all government systems, the lines include some which have an exceedingly light traffic and which have to be carried by the stronger main lines; but the result seems not unfavorable, especially when it is considered that very few countries have so small a population per mile of road as New South Wales.

A new building in Chicago is to have its outer coat or front entirely of aluminum bronze and glass. The effect will certainly be striking and novel.

The total tonnage of freight passing through the Sault Ste. Marie Canal in September was 1,661,303, of which 1,233,403 tons were eastward and 427,900 tons westward bound. The heaviest items of freight were 812,153 tons of iron ore; 363,673 tons of coal; 3,993,318 bushels of wheat, and 755,802 barrels of flour. The water route still controls a large share of the grain traffic.



LOCOMOTIVE NO. 903, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

At the September meeting of the Western Railroad Club Mr. A. M. Waitt, of the Lake Shore road, treated the subject of Steam Heating for Cars in a carefully prepared paper. His conclusions are strongly in favor of the direct system of heating for passenger cars, while he admits the advantages of the indirect system for sleeping cars. An essential point in any system, he thinks, is the provision of means for supplying steam to standing cars at terminal stations and important junction points.

At the September meeting of the New York Railroad Club Mr. Hugh Baines presented an interesting paper on the relation of rolling stock and track, based on experi-

ence with a number of special stock cars in use between New York and Chicago. His argument is in favor of the longest wheel-base possible for a truck and for as solid a frame as can be secured. He says also that lowering the side-bearings so as to throw most of the weight on the center-bearing was followed by a rapid increase in flange friction, and from this he draws the obvious conclusion.

THE second paper at the New York Club meeting was read by Mr. F. A. Stinard, and was on Boiler Scale and Purification of Water. There are very few who do not recognize the importance of this subject, but unfortunately there is little agreement on the best means of improving the quality of water. The plan described in the paper has the merit of simplicity, while its efficacy has been tested under very trying circumstances.

A NEW YORK CENTRAL FAST LOCOMOTIVE.

THE illustration given herewith is from a photograph of Engine No. 903, of the New York Central & Hudson River Railroad, which claims the largest driving-wheels in America.

This engine was built by the Schenectady Locomotive Works, and was originally of the standard pattern used on this road for heavy and fast passenger service. It has recently been rebuilt in the company's shops at West Albany, where it received the larger driving-wheels and other alterations made necessary by their use.

The boiler is of large size and has 1,821.5 sq. ft. heating surface. The usual working pressure is 180 lbs. The cylinders are 19 × 24 in. and the driving-wheels are 7 ft. 0¼ in. in diameter. Their size and the great height of the engine are shown by contrast in the photograph.

The total weight of this engine is 121,000 lbs., of which 81,000 lbs. are carried on the drivers and 40,000 lbs. on the truck.

The tender weighs in service 80,000 lbs.; it carries 3,587 galls. of water and 7 tons of coal. It is provided with a scoop for taking up water from the track tanks without stopping. The total weight of engine and tender ready for service is thus 201,000 lbs.

This engine is employed in running the "Empire State Express" between New York and Albany, the schedule time of the train being 52 miles an hour. From some indicator diagrams taken while the engine was running at the rate of 76 miles an hour, it appears that at that speed there was 1,120 H.P. developed. The usual train is four cars.

While this engine has the largest drivers now in use in this country, they are not the largest that have been built here. Reference has been made in our columns* to some old engines on the Camden & Amboy Railroad which had a single pair of driving-wheels 7 ft. 6 in. in diameter. In fact there was, some 35 or 40 years ago, a tendency to use larger drivers than have since been common, although 6 ft. was seldom exceeded. The engines referred to, however, were very much lighter than our present types, and could not have handled the heavy cars and trains now in use.

An engine of the same class, but having driving-wheels 6 ft. 6 in. in diameter, made a somewhat unusual run with a special train on October 4. The engine—No. 870—and tender weigh 201,000 lbs., and the weight of the train was 592,700 lbs., making a total of 793,700 lbs. The train consisted of five ordinary passenger cars and five sleeping cars. The run from Albany to Poughkeepsie was made in 1 hour 17 minutes, the average rate of speed being 54 miles an hour. The wind at the time was heavy, blowing from the west. The steam pressure during the run was kept at 160 to 170 lbs. The speed maintained was certainly remarkable, considering the weight of the train.

* See the RAILROAD AND ENGINEERING JOURNAL for January, 1892, pages 10 and 11.

SOME COMPOUND LOCOMOTIVE TESTS.

IN response to the article on Compound Locomotives in the September number of the JOURNAL, Mr. F. W. Johnstone, Superintendent of Machinery of the Mexican Central Railroad, has sent us a report of some tests conducted on his road. Unfortunately his letter was received too late to publish the tables accompanying it, but the results are as fully given as possible.

The tables show the performance of six compound locomotives for the months—November 1, 1891, to August 31, 1892—in actual service, as compared with six simple locomotives of equal tractive force and practically the same weight, the dimensions being as follows: Compound, cylinders, 14 in. and 24½ in. × 24 in.; drivers, 56 in.; weight on drivers, 104,000 lbs.; grate area, 27.3 sq. ft.; heating surface, 2,004 sq. ft.; boiler pressure, 175 lbs. The dimensions of the simple engines are: Cylinders, 20 in. × 24 in.; drivers, 48 in.; grate area, 30.4 sq. ft.; heating surface, 1,801 sq. ft.; boiler pressure, 150 lbs.

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ON October 1 the tables of the *American Manufacturer* show that there were 242 furnaces in blast, having a total weekly capacity of 161,558 tons of pig iron. This is a slight increase over the September report, the producing capacity having gained about 3 per cent. during the month. It is a considerable decrease—11 per cent.—from October of last year, however; but the rate of production was then extraordinary, many of the large bituminous and coke furnaces having just blown in after a long stop. The production this year has been much steadier and more uniform than in 1891.

LOCOMOTIVE NO. 903, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AT the new ship-yard of the Maryland Steel Company, in Baltimore, it is proposed to do away with launches by building ships in dry-docks, which can be flooded when a vessel is ready. This plan has been suggested before and occasionally used—notably with some of the large English battle-ships—but has never, we believe, been made a regular feature of a yard.

THE report of the Railroad Commission of New South Wales for the year ending June 30 last shows that the Colony has 2,266 miles of railroad in operation. The general depression of business affected the roads, but their total earnings were about $15,536,000 gross and $5,965,000 net. The surplus remaining was sufficient to pay 3.58 per cent. on the capital invested in the construction of the roads. Like all government systems, the lines include some which have an exceedingly light traffic and which have to be carried by the stronger main lines; but the result seems not unfavorable, especially when it is considered that very few countries have so small a population per mile of road as New South Wales.

A NEW building in Chicago is to have its outer coat or front entirely of aluminum bronze and glass. The effect will certainly be striking and novel.

THE total tonnage of freight passing through the Sault Ste. Marie Canal in September was 1,661,303, of which 1,233,403 tons were eastward and 427,900 tons westward bound. The heaviest items of freight were 812,153 tons of iron ore; 363,673 tons of coal; 3,993,318 bushels of wheat, and 755,802 barrels of flour. The water route still controls a large share of the grain traffic.

AT the September meeting of the Western Railroad Club Mr. A. M. Waitt, of the Lake Shore road, treated the subject of Steam Heating for Cars in a carefully prepared paper. His conclusions are strongly in favor of the direct system of heating for passenger cars, while he admits the advantages of the indirect system for sleeping cars. An essential point in any system, he thinks, is the provision of means for supplying steam to standing cars at terminal stations and important junction points.

AT the September meeting of the New York Railroad Club Mr. Hugh Baines presented an interesting paper on the relation of rolling stock and track, based on experi-

ence with a number of special stock cars in use between New York and Chicago. His argument is in favor of the longest wheel-base possible for a truck and for as solid a frame as can be secured. He says also that lowering the side-bearings so as to throw most of the weight on the center-bearing was followed by a rapid increase in flange friction, and from this he draws the obvious conclusion.

THE second paper at the New York Club meeting was read by Mr. F. A. Stinard, and was on Boiler Scale and Purification of Water. There are very few who do not recognize the importance of this subject, but unfortunately there is little agreement on the best means of improving the quality of water. The plan described in the paper has the merit of simplicity, while its efficacy has been tested under very trying circumstances.

A NEW YORK CENTRAL FAST LOCOMOTIVE.

THE illustration given herewith is from a photograph of Engine No. 903, of the New York Central & Hudson River Railroad, which claims the largest driving-wheels in America.

This engine was built by the Schenectady Locomotive Works, and was originally of the standard pattern used on this road for heavy and fast passenger service. It has recently been rebuilt in the company's shops at West Albany, where it received the larger driving-wheels and other alterations made necessary by their use.

The boiler is of large size and has 1,821.5 sq. ft. heating surface. The usual working pressure is 180 lbs. The cylinders are 19 × 24 in. and the driving-wheels are 7 ft. 0½ in. in diameter. Their size and the great height of the engine are shown by contrast in the photograph.

The total weight of this engine is 121,000 lbs., of which 81,000 lbs. are carried on the drivers and 40,000 lbs. on the truck.

The tender weighs in service 80,000 lbs.; it carries 3,587 galls. of water and 7 tons of coal. It is provided with a scoop for taking up water from the track tanks without stopping. The total weight of engine and tender ready for service is thus 201,000 lbs.

This engine is employed in running the "Empire State Express" between New York and Albany, the schedule time of the train being 52 miles an hour. From some indicator diagrams taken while the engine was running at the rate of 76 miles an hour, it appears that at that speed there was 1,120 H.P. developed. The usual train is four cars.

While this engine has the largest drivers now in use in this country, they are not the largest that have been built here. Reference has been made in our columns* to some old engines on the Camden & Amboy Railroad which had a single pair of driving-wheels 7 ft. 6 in. in diameter. In fact there was, some 35 or 40 years ago, a tendency to use larger drivers than have since been common, although 6 ft. was seldom exceeded. The engines referred to, however, were very much lighter than our present types, and could not have handled the heavy cars and trains now in use.

An engine of the same class, but having driving-wheels 6 ft. 6 in. in diameter, made a somewhat unusual run with a special train on October 4. The engine—No. 870—and tender weigh 201,000 lbs., and the weight of the train was 592,700 lbs., making a total of 793,700 lbs. The train consisted of five ordinary passenger cars and five sleeping cars. The run from Albany to Poughkeepsie was made in 1 hour 17 minutes, the average rate of speed being 54 miles an hour. The wind at the time was heavy, blowing from the west. The steam pressure during the run was kept at 160 to 170 lbs. The speed maintained was certainly remarkable, considering the weight of the train.

* See the RAILROAD AND ENGINEERING JOURNAL for January, 1892, pages 10 and 11.

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READY FOR THE START.

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The advocates of the compound system generally claim the privilege of increasing the weight of the front ends of their locomotives, and argue that any addition to the weight on the truck is a matter of no importance. But sauce for the goose is, proverbially, sauce for the gander. If an addition to the weight on the truck of a compound locomotive is permitted, the same privilege should also be allowed to the simple engine. As a matter of fact, important consequences may result by increasing the weight on the truck of a simple engine, as a longer and more economical boiler may thus be used. The compound system involves the use of larger cylinders, steam-pipes, and other parts, with a consequent increase in weight. To the extent to which the weight of these parts is increased, the compound system is a disadvantage, and the advocates of simple engines may justly claim the privilege of utilizing an equal addition to the weight of their engines. To make a comparison of simple and compound locomotives fair, the *total weight* of each should be the same. Was this the case with the engines tested by Mr. Johnstone? His figures show that the compounds had 4,000 lbs. more weight on the driving-wheels than the simple engines had, but do not show the difference on the trucks. Furthermore, what were the relative ages of the two classes of engines? It will be seen that the cost of repairs of the compounds was greater than for the simple machines. Now, if the compounds were new and the simple engines were old, this difference is significant.

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The railroad companies of this country, representing millions of employés and billions of capital, and controlled and directed by men of high intelligence, have a commanding influence in every legislative hall in the United States.

Every railroad corporation can request its officers, agents, and employés to do what they can to create a right sentiment in regard to the improvement of highways in their respective neighborhoods; and all along the various lines depot-masters and freight agents could report to a Road Department, established by the company, the condition of the roads in their towns and what is being done to improve them. These depot-masters could be furnished from time to time with pamphlets containing instructions for the construction and maintenance of highways, for distribution to persons doing business at their stations, and thus educate them how to build better roads, as well as teach them that better highways effect saving in transportation. Any railroad running through a territory hav-

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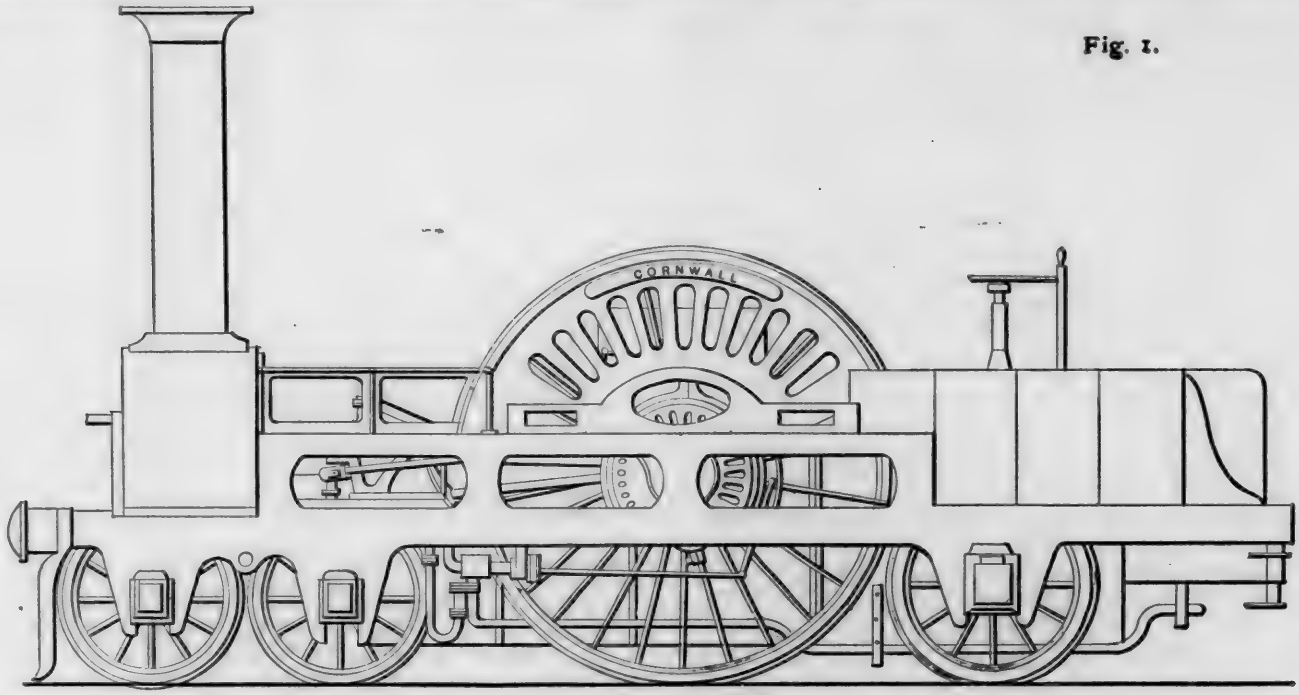
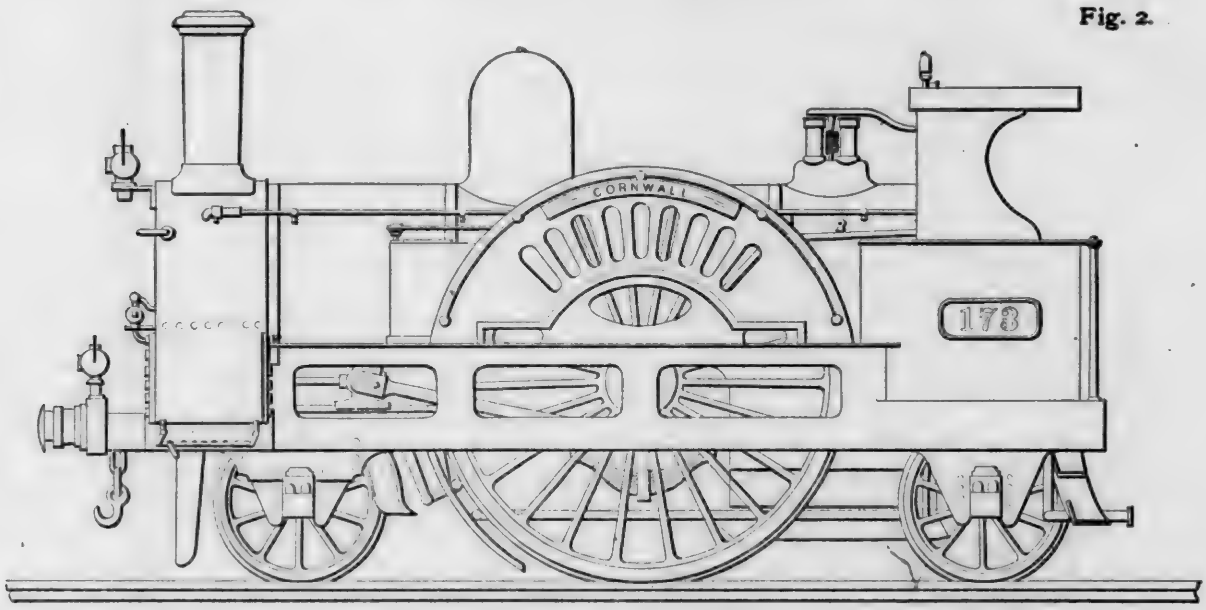


LOCOMOTIVE "CORNWALL."

As originally designed by J. Trevithick and built for the London & Northwestern Railway in 1847.

Fig. 2.



LOCOMOTIVE "CORNWALL."

As altered by Mr. Ramsbottom and Rebuilt in 1862–63.

ing good roads must have a great advantage over a competing line with poor roads from its stations.

The executive officers of a railroad corporation can instruct representatives in Congress on the importance of better highways so that favorable legislation may be secured; newspapers to whom railroad companies extend their patronage might be requested to devote space to agitating this matter.

The building up of suburban districts, which is of such a profitable character to railroads, is first brought about by the construction of good roads by those who wish to sell land.

Aside from the material advantages that may accrue to a railroad by its aiding in the work of agitating this subject, there is to be considered the broader question of the great benefits that might be conferred upon the entire community.

Will you not aid this great movement which is of so much national importance?

THE LOCOMOTIVE "CORNWALL."

As the subject of large driving-wheels is now discussed a good deal, we have reproduced two engravings from the *English Mechanic*, which, it is said, "has been for some time past the engine with the largest driving-wheels in existence." It was described as follows by a correspondent in the paper referred to:

She was designed by J. Trevithick, and built in 1847, and was shown in the Exhibition of 1851. Fig. 1 represents the engine as originally constructed. The boiler, it will be seen,

went under the driving-axle, and she ran on eight wheels; but Mr. Ramsbottom rebuilt and altered her, in 1862–63, to her present state, as shown in fig. 2, with the exception of the cab, which has since been added by Mr. Webb.

Dimensions: Cylinders, 17½ in. diameter × 24 in. stroke; wheels, diameter of leading and trailing, 4 ft.; wheels, diameter of driving, 8 ft. 6 in.; weight of engine in working order, 63,840 lbs.

The object in building the *Cornwall* was to prove that the narrow gauge could have a larger driving-wheel—namely, 8 ft. 6 in.—than the Great Western—7 ft. gauge engines of that time. The *Cornwall* when new, it is said, attained a speed of fully 79 miles an hour, and to-day it can run as fast as any locomotive that exists.

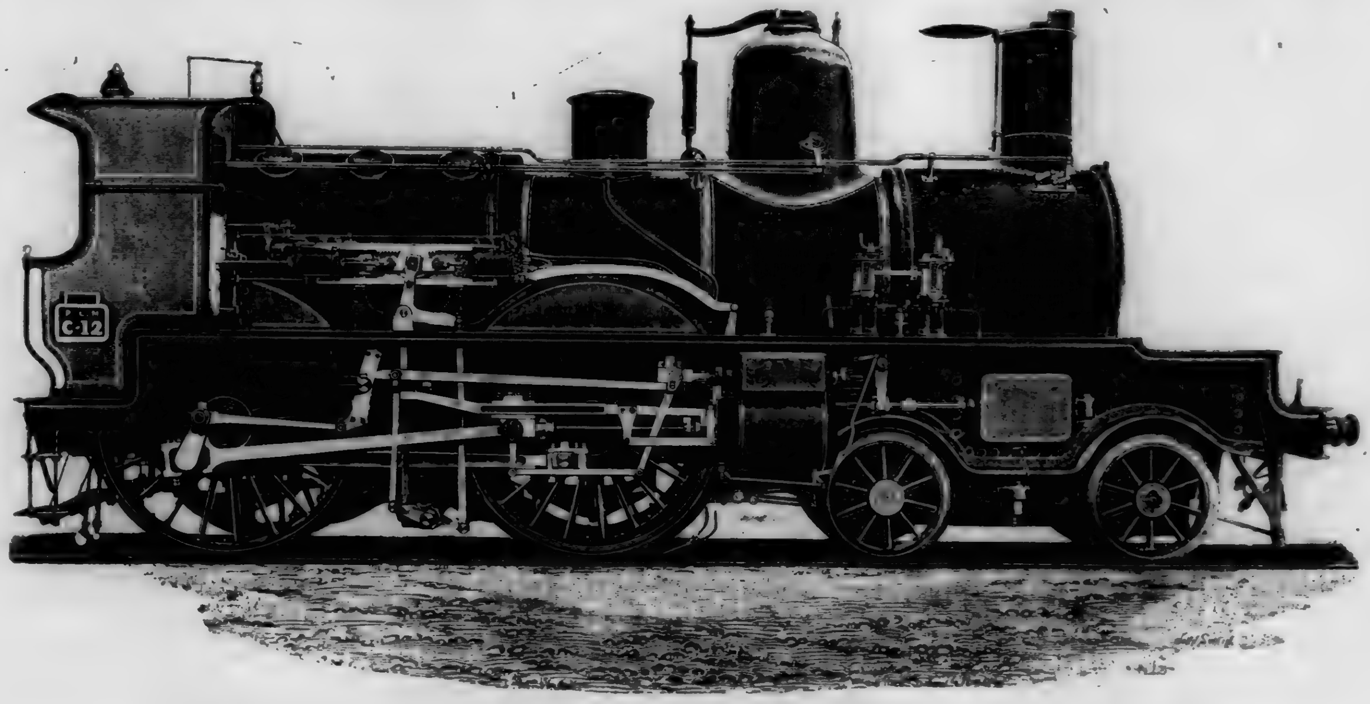
Mr. Clement E. Stretton, who is our authority on this subject, says that the largest wheels ever used were 10 ft. in diameter, with which the *Hurricane* on the Great Western Railway was fitted.

A FRENCH COMPOUND LOCOMOTIVE.

We have taken from the London *Engineer* the accompanying illustration of a compound locomotive designed for fast passenger work by M. Baudry, Chief Engineer of Traction of the Paris, Lyons & Mediterranean Railroad, and which has just been put in use on that road. The engine is of the same general design as the four-cylinder compound designed for the Northern Railroad of France by M. Du Bousquet, which was fully described and illustrated in the August number of the Journal. In general it may be said that the engine is of the eight-wheel American type, with four driving-wheels, and a four-wheel truck forward. The high-pressure cylinders are placed outside, behind the truck or nearly in the center of the length of the barrel of the boiler, and are connected to the rear pair of driving-wheels. The low-pressure cylinders are under the smoke-box inside, and are connected to the forward pair of drivers through a crank-axle. The high-pressure cylinders are 13.40 in. and the low-pressure 21.25 in. in diameter, having 24.40 in. stroke. The driving-wheels are 6.56 ft. in diameter. The ratio between the high and the low-pressure cylinders is thus 1 : 2.42.

As in M. Du Bousquet's engines, there are separate valve-motions for the high and low-pressure cylinders, and the connections are so arranged that the engineer can reverse both with one motion or can move them separately for adjustment as he desires. The total weight of this engine is 48 tons, of which about 30 tons are carried on the driving-wheels.

The chief difference between this engine and that of the Northern Railroad is in the very high pressure used, which is intended to be 215 lbs. This is the highest working pressure yet used in a locomotive. The Northern Railroad engine was intended to work at 195 lbs. The boiler is, like those of many of the engines on the same road, provided with the Servé ribbed tubes, and from experience had with these tubes, it has been considered possible to make the boiler barrel shorter than is generally the case with engines of this size. The tubes are 10 ft. long or 2.8 ft. less than those of the Northern engine, but the heating surface as estimated is greater, being 1,620 sq. ft. The grate area is 25 sq. ft.



COMPOUND LOCOMOTIVE FOR PARIS, LYONS & MEDITERRANEAN RAILROAD.

It may be added that the locomotive frames are of the plate type usually employed in France, and that both locomotive and truck frames are of steel. The truck-wheels are 39.37 in. in diameter. The first of these engines—the Company is building several at its works near Paris—is only just ready for service and has not been actually tried in actual work.

EFFECT OF TEMPERATURE ON THE STRENGTH OF AXLES.

(From the *Practical Engineer.*)

In a recent paper on this subject, read before the Institution of Civil Engineers, Mr. Thomas Andrews has given some data which he obtained from a series of experiments. The conclusions drawn from these tests compare closely with some results found in actual service that are cited in the paper. In the tests 18 axles were subjected to a cold test as follows:

The axles were allowed to cool gradually to a temperature of normal rigidity—that is, the atmospheric temperature at the time they were made. They were then buried separately in about 30 tons of snow, for various periods of time. When the axles were removed from this they were placed in a cooling cage, surrounded by a large quantity of freezing mixture, composed of two parts of snow and one part by weight of salt, for 13 hours, or until the metal

had become cooled to 0° Fahr. They were then placed in an axle drop on bearings 3 ft. 6 in. apart, and subjected to one blow from a one-ton weight falling from a height of 5 ft. The extent of deflection between the bearings was carefully taken after each blow. The axle was placed in the freezing mixture for 15 minutes after each blow was delivered, so as to make sure that its temperature was 0° throughout the tests. The operation was repeated until fracture occurred.

Warm tests were made with 11 axles. After forging, these axles were allowed to cool to a temperature of normal rigidity, and were then placed in a large water bath, which was gradually raised to 100° Fahr. Each axle was then removed to the drop test, and immediately tested in the usual manner, one blow being given and the deflection measured. After each blow the axle was placed in the bath 15 minutes. In general, these tests were made in the usual manner of drop tests, the axle being turned half way over after each blow.

The results of these experiments show that, at a temperature of 0° Fahr., the total average mean force of 179⅞ tons was sufficient to cause the breaking of the axle; and at a temperature of 100° Fahr. the total average mean force of 428½ tons was necessary to fracture—that is, the resistance to concussion at a temperature of 0° was about 42 per cent. of what it was at 100°. The average total deflection at 0° was 6.48 in. as against 15.06 in. at 100°. This represents a reduction of flexibility under the drop test of about 57 per cent.

The author of this paper gives the following conclusions on the whole series of observations made in connection with these tests, which have been proceeding during the last seven years:

1. The impact tests, with an energy of 10 foot-tons on axles, at a temperature of 212° Fahr., compared with the results at 7° Fahr., indicated an increase of endurance at the higher temperature of about 235 per cent.

2. The impact tests, with an energy of 15 foot-tons on axles, at a temperature of 120° Fahr., compared with the results at 7° Fahr., showed an increase of endurance at the higher temperature of nearly 120 per cent.

3. The impact tests, with an energy of 10 foot-tons on axles, examined at a temperature of 100° Fahr., when contrasted with results obtained at 7° Fahr., demonstrated an increase of resistance at the higher temperature of about 43 per cent., and this increase was within certain limits in proportion to the increase in temperature.

4. The impact tests, with an energy of 5 foot-tons of axles, at a temperature of 100° Fahr., gave an increase of resistance of about 138 per cent., compared with results on axles similarly tested at a temperature of 0° Fahr.

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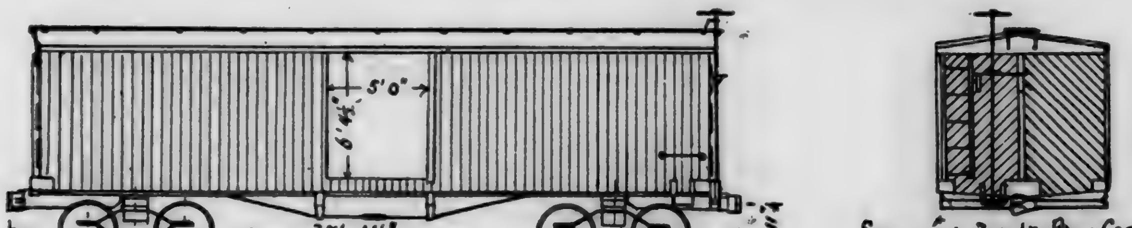

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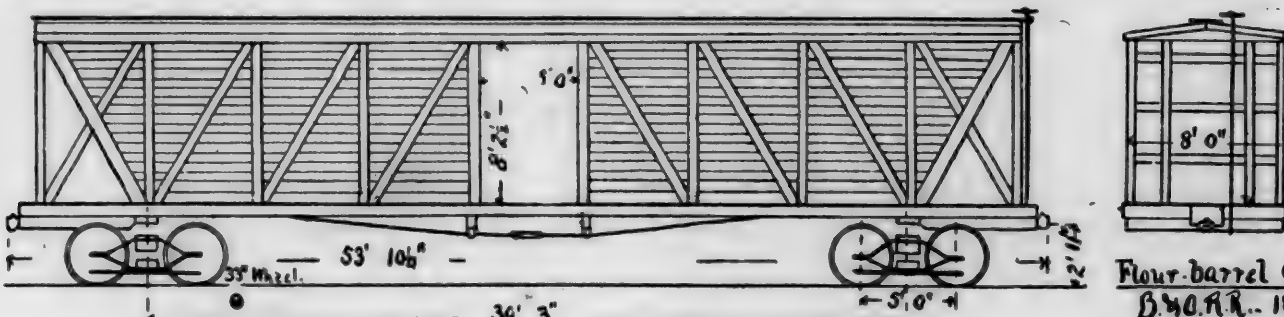

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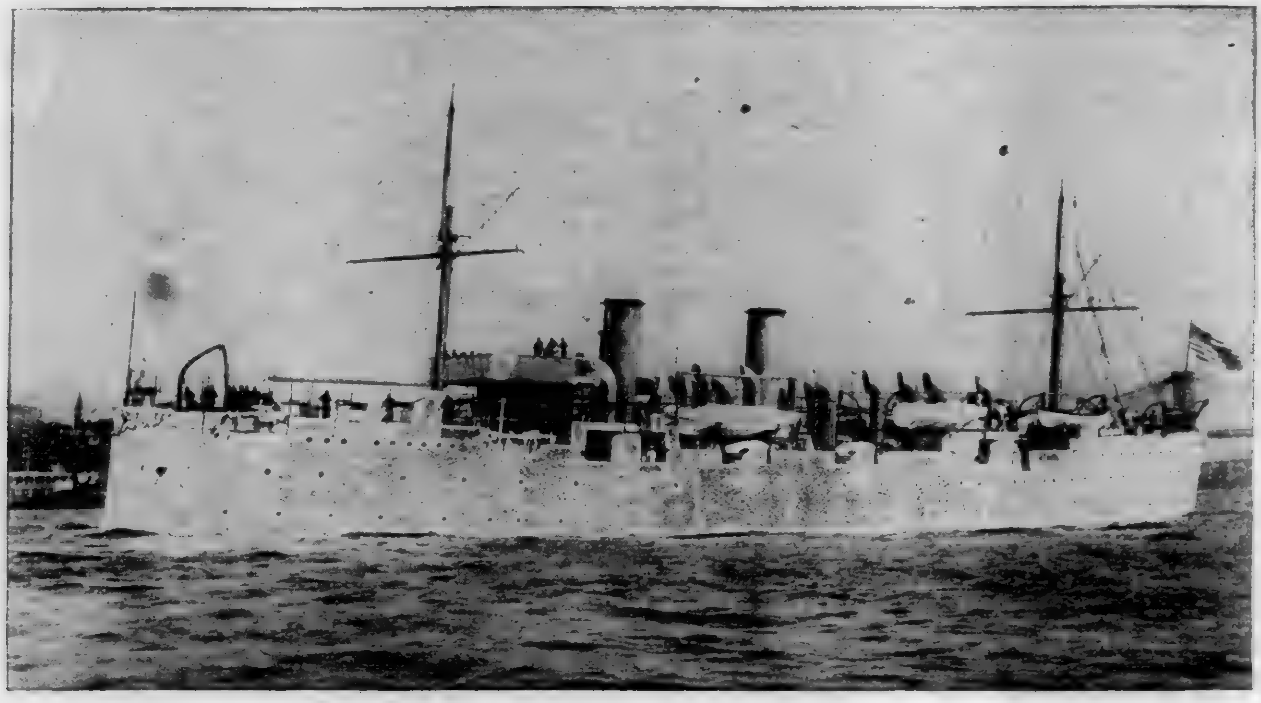

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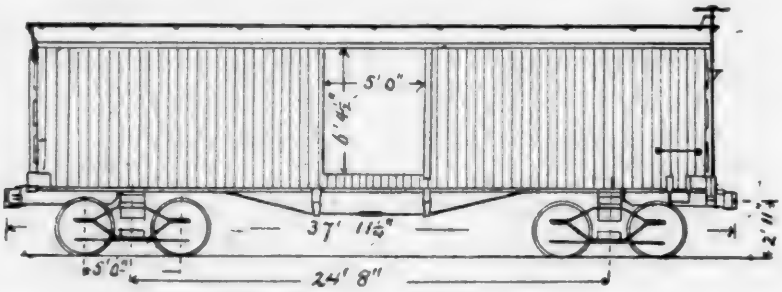

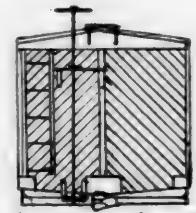

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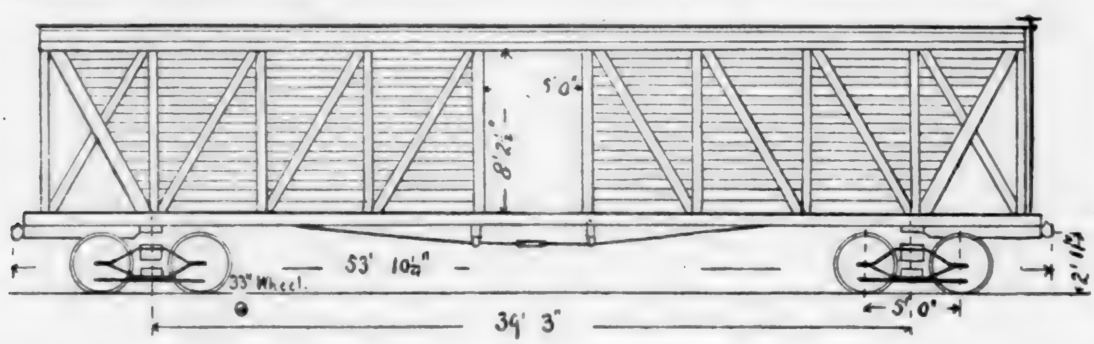

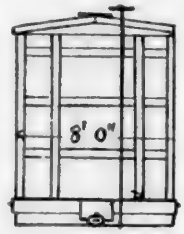

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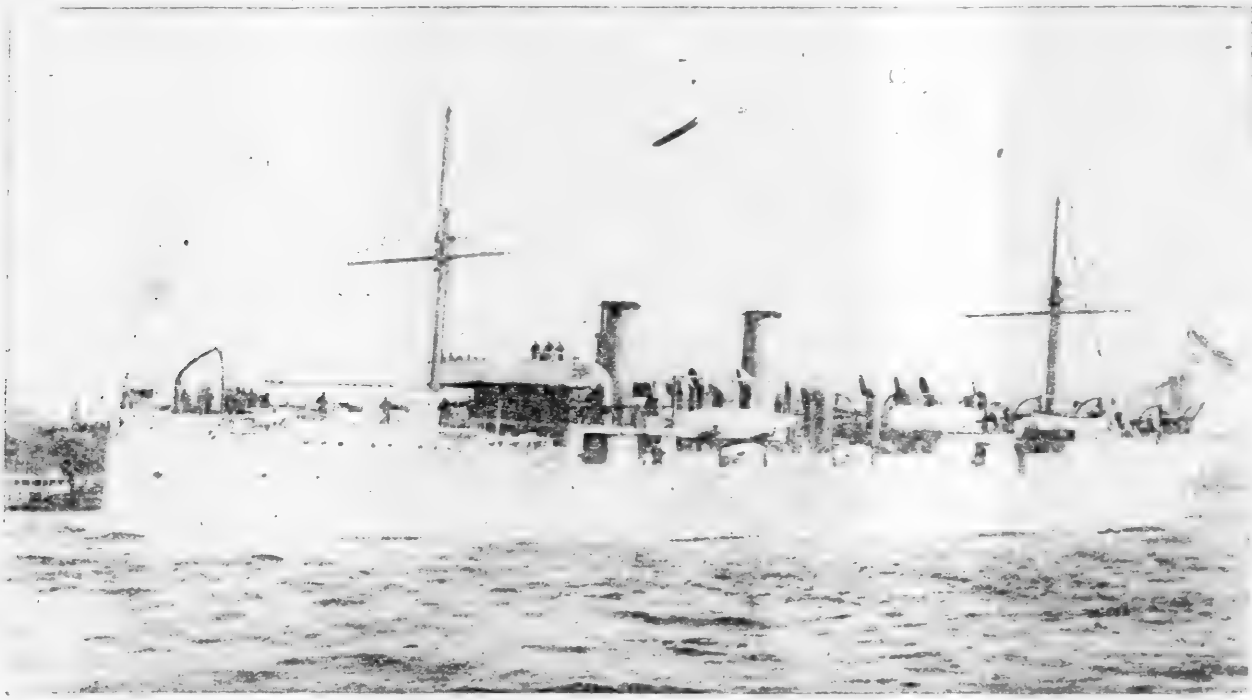

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there are one or more still used as shifting engines at Mount Claire station, Baltimore, Md."

In competition with other engines, Phineas Davis won the first prize of $3,500 for making the first engine in America that was successfully worked that burned anthracite coal.

He soon afterward removed to Baltimore, when he became Superintendent of the large shops of the Baltimore & Ohio Railroad, and prospered in his enterprises. He was a diligent worker. Mr. Rupp, of Hanover, now living, was one of his employés. Davis lost his life by accident. He had command of one of his engines, and was taking a party of Baltimoreans on an excursion, when a few miles out from the city one of the iron rails on the left side of the track bent and broke, flew with great force backward, and struck him while on the engine, and he was instantly killed, on September 27, 1835. His death was deeply lamented.

He was a native of York, and August 15, 1826, was married in the Friends' Meeting House, at York, to Hannah Taylor, the great-granddaughter of William Willis, who built the first court house. He was only about 40 years old when he was killed. A great many car wheels and other foundry products were made at the York foundry. It was last owned by Judge Ducker and Samuel Slaymaker. There was attached to these works a steam grist-mill, carding-mill and fulling-mill. Joel Fisher was manager of the last two. The steam grist-mill burned down.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

(*Concluded from page* 469.)

THE REQUIRED DEPTH OF FOUNDATIONS.

The required depth of the foundations of the abutments and piers should be calculated by the formula of Rankine, which we find suitable in the form

$$h > H' \; tang.^4 \left(\frac{90 - \phi}{2}\right),$$

where H' is the height of a column of sand, whose weight is equal to the weight of the structure, ϕ is the angle of repose or of natural slope of the ground (for sand $\phi = 30°$; for clay, $= 35°$); and h is the required depth of foundation.

The value of H' is computed in the following manner: If n is the weight of the structure with the load transmitted to it by the superstructure—its dead and living load; F = the area of base, and $\Delta = \frac{n}{F}$, the pressure on a square unit of the base and δ the weight of a cubic unit of sand, then

$$H'\delta = \Delta \quad \therefore \; H' = \frac{\Delta}{\delta},$$

and the formula can be written

$$h > \frac{\Delta}{\delta} \; tang.^4 \left(\frac{90 - \phi}{2}\right).$$

If, after the washing out of the bed, the depth of base of the foundation is H, then it is necessary that the coefficient of stability m be:

Before washing out,

$$m = \frac{H}{h} = \frac{2}{[illegible]}$$

After washing out,

$$m' = \frac{H + l}{h} = \frac{3.25}{3.5}$$

Observation.—For the abutments the pressure from the earth behind should be taken into consideration.

ELEVATION OF THE SUPERSTRUCTURE ABOVE HIGH WATER.

For construction of truss bridges over great rivers, two chief conditions as to the elevation should be satisfied:

1. The base of the pier masonry should rise 1½ ft. above the level of highest water.
2. The lower flange of the girders should be so elevated that the largest vessels in use on the river can pass under them.

DIVISION OF THE TOTAL CLEAR OPENING INTO SPANS—DISTRIBUTION OF SPANS.

The division of the total clear opening into spans, or the distribution of spans and their length, depends upon local conditions, such as the depth of the river, the direction of the current, the kind of subsoil, the maximum length available under the system of girders adopted, etc.

The piers should be so placed that they leave the main channel free, and if the channel takes the center of the river, the number of spans is generally odd. The length of each span should be sufficient for passing large vessels and rafts. Sometimes the length of the span is controlled by the necessity of putting the piers on sites where the foundations are easily made, and in that case all the spans do not need to be equal.

As a general rule, we can say that when the spans are longer, then the superstructure is more expensive, and the number and cost of piers are less; on the contrary, when the length of spans is less, then the superstructure is cheaper, and the piers cost more. Therefore, the length of spans should be so chosen that the total cost of the bridge be the least.

For bridges with metallic superstructure and stone piers founded on caissons, we can suggest the following considerations:

Let us assume

l = total clear opening of bridge in feet,
x = the most advantageous length of span;

then the weight of a lineal foot of superstructure in pounds is given by a formula of the form $Cx + F$, where C and F are constant co-efficients, F designating the weight of the floor.

Further, let

p = price of a unit weight of metal,
P = total cost of one pier;

then the total cost of the bridge K is

$$K = (C\,x + F)\,p\,l + \left(\frac{l}{x} + 1\right) P.$$

In order to find the value of x, corresponding to the minimum of K, differentiate this equation, and put $\frac{d\,k}{d\,x} = o$; then

$$\frac{d\,k}{d\,x} = C\,p\,l - P\frac{l}{x^2} = o;$$

therefore

$$x = \sqrt{\frac{P}{C\,p}}.$$

For ordinary trusses 200 to 400 ft. in length—of the Linville or a similar system—the quantity C has a value of 7.5 to 8.5, in pounds, the value of p can be assumed at 4 to 5 cents per pound, and the value of P = a sum which may be calculated on the basis of local prices of stone, cement, and other materials.

In the case of a majority of the larger bridges, the arrangement of spans has been determined by extraneous considerations, chiefly by the location of the current and the nature of the navigation. It may be said in a general

way that this is one of the most difficult questions to decide, and that it is almost impossible to determine it by any fixed formula. It is here that the judgment of the engineer will be best displayed, and the exercise of his best faculties will be required.

ELECTRICITY IN WELDING AND METAL WORKING.

(Paper read by A. B. Wood, of Detroit, and published in the *Proceedings* of the American Institute of Mining Engineers.)

IN welding and metal working by electricity two systems are in use: the so-called *Incandescent System*, in which the material operated upon is traversed by currents of large volume and low electro-motive force, the current having a continuous metallic circuit during the welding operation; and the *Arc System*, in which the electric arc is utilized.

It is the purpose of this paper to call attention to this last system of electric welding as one of the recent developments in the art of metal working.

In the arc system of electric welding the material may be included in the electric circuit, or may be wholly without the circuit; in either instance the enormous heat of the electric arc is brought into requisition and utilized in the welding or metal-working operation.

In the Coffin arc-welding system, invented by C. L. Coffin, of Detroit, the material is in the electric circuit or independent of it, as the case may require, different processes being applied as may be best suited to the work.

It is not the intention in this paper to give a description of the various machines and appliances employed, as improvements are being perfected and the inventor prefers to hold such descriptive matter in reserve until he shall have secured the protection of patents.

The apparatus used in this arc system of metal working is of the simplest character. It can be used upon continuous or alternating currents, upon light or power-circuits, either arc or incandescent.

In the earlier attempts at arc welding with the Bernardos process, difficulty was experienced in obtaining clean and homogeneous welds. This objection does not apply to the Coffin system.

In the Bernardos process the material is connected to one terminal of the generator, and the tool, generally a carbon electrode, connected to the other terminal. Contact is made between the tool and material to establish the circuit, and an arc is sprung between the tool and material by separating them slightly after the current has been turned on. The carbon electrode is slowly traversed along the point or part to be welded, the intense heat of the arc fusing the metal at or in the neighborhood of the joint. Since the regulating and maintaining the arc at proper length is done by hand, much difficulty is experienced in securing a uniform arc, while the regulation of the dynamo is almost an impossibility; the material is subjected to too severe treatment and, in many instances, notably in working on steel or iron, a chill is formed at the weld, or the metal is overheated and greatly oxidized.

With the Coffin system of arc welding this difficulty is entirely obviated, the material not suffering in the least from the treatment; clean, neat welds are made with but little oxidation; no chilling or burning is manifest; the arc is under perfect regulation, and the heating of the material is entirely under control of the operator. Generally no flux is used in the welding operation, so slight is the scaling or oxidation, though, if desired, fluxes may be used in special instances, as in the welding of polished metal.

This arc system of metal working is of very general adaptability, being readily applied to bar, shaft, axle, ring, hoop, tire, pipe, sheet-metal, angle-iron, frame and boiler-work. A 1 H.P. arc welder has a capacity up to one inch of round iron; its cost of maintenance is but a few cents per day for power supplied at the dynamo when power is rented, or at a rating of a single arc lamp when current is supplied from light or power circuits.

A welder of 1 H.P. has a capacity of one weld per 15 seconds, operating upon ¼-in. round iron. This capacity can be increased according to the skill and rapidity of the operator. The same welder handles ½-in. and ⅝-in. round iron with equal facility, and can be utilized upon ¾-in. and 1-in. work. The butt welding of pipe is obtained with the same ease and perfection of results.

The arc system of welding seems destined more especially to give material aid in work on sheet metal, tubes, and boilers, since the tremendous heat of the arc can be readily applied where most needed. The heating of the material is not dependent upon its electrical resistance, or its current-carrying capacity, nor is perfect contact at the joint a necessity; while these are points of the utmost importance in operating upon such work under the incandescent system. With that, the current required to weld a 5-ft. seam in ½-in. iron plates is something enormous, and the cost of generator and of power to drive it is correspondingly great; while under the arc system the plant required would be insignificant in comparison. It is not the intention of the writer to disparage the incandescent system of electric welding, for it has great use, but to call attention to the fact that arc welding is an established process, in successful operation, and bids fair to assume a position of great importance in metal-working operations.

The mechanical application of arc welding is readily made. Since the material may be either within or without the circuit, and the heating effect is independent of the current-carrying capacity of the material, no exacting provisions have to be made for electrical contact, or large current-carrying capacity in the material itself. Hence heavy copper castings and retaining clamps are unnecessary; no cooling appliances are required, and in most instances the welder proper may be applied to existing apparatus or machinery with slight alteration. An advantage of this method may be noticed in the welding of hoops and tires, in that it does not require special precautions to prevent short circuiting of the current around the joint, or the use of an abnormal current to cover the effects of such a short circuit, or shunt, should it occur. A hoop of ½-in. or ¾-in. round iron is neatly and rapidly welded on a 1 H.P. arc welder; a feat quite impossible with like power under the incandescent system.

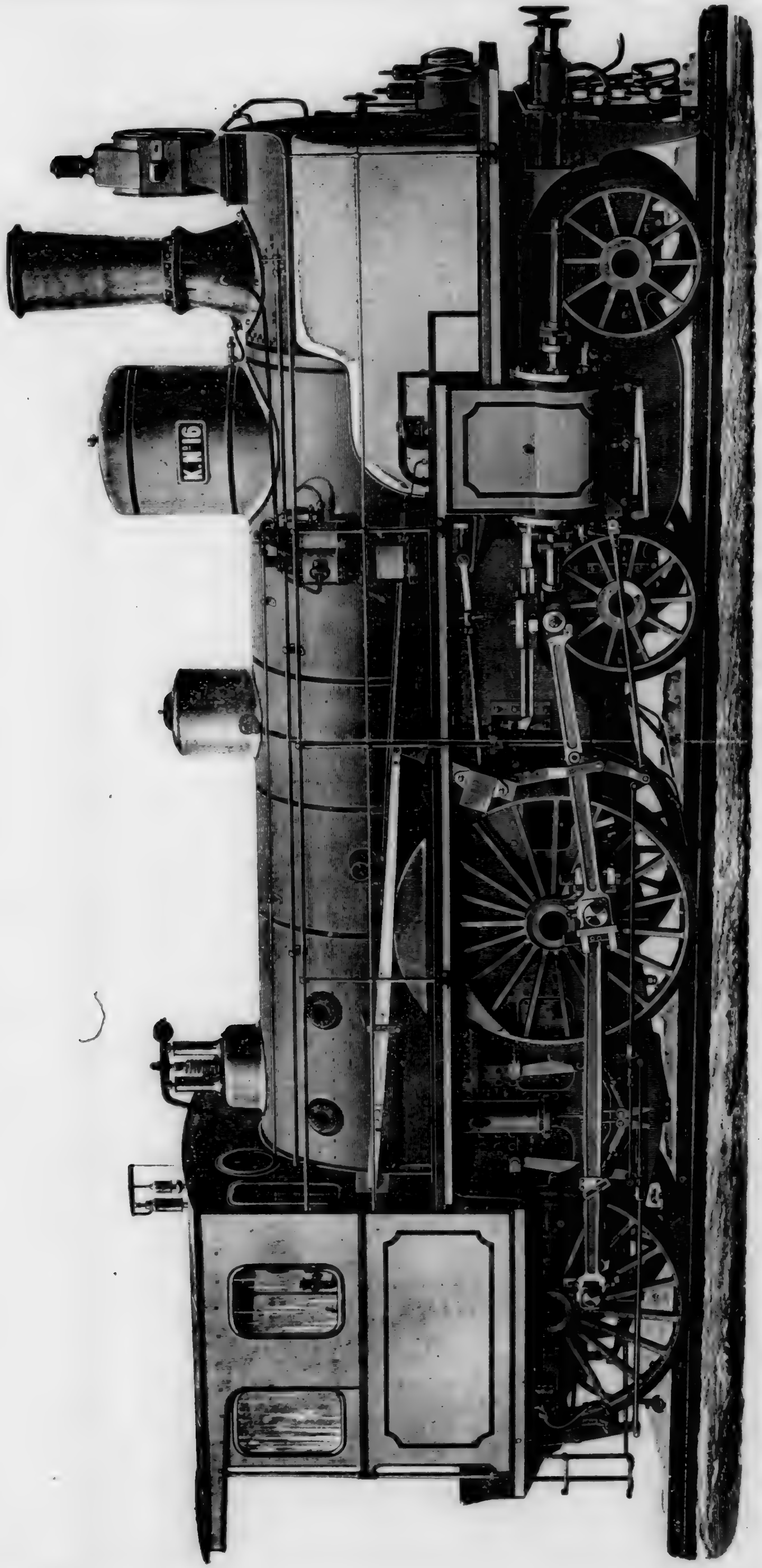
With larger power the work possible to be done is much more general in its nature. With a 50-H.P. arc welder work of large proportions can be handled, and large shafts welded as readily as small bars on the lighter machines. Rails, shafts, and similar work may be treated in this way. It must be especially noted that the iron is left in a very soft and natural condition at the weld.

The simplicity of the apparatus, its small cost of maintenance, and the wide range of work possible with a welder of small power renders the arc system of interest to bridge builders, mine operators and others, whose operations in the field do not permit the use of extensive power plants and generators. A 10-H.P. or 20-H.P. arc welder has capacity for most of the work called for in bridge construction, such as welding eye-bolts, spanner rods, plates, etc., and for repairs needed during erection. The dynamo used for welding in the daytime can be utilized for lighting at night.

A COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE.

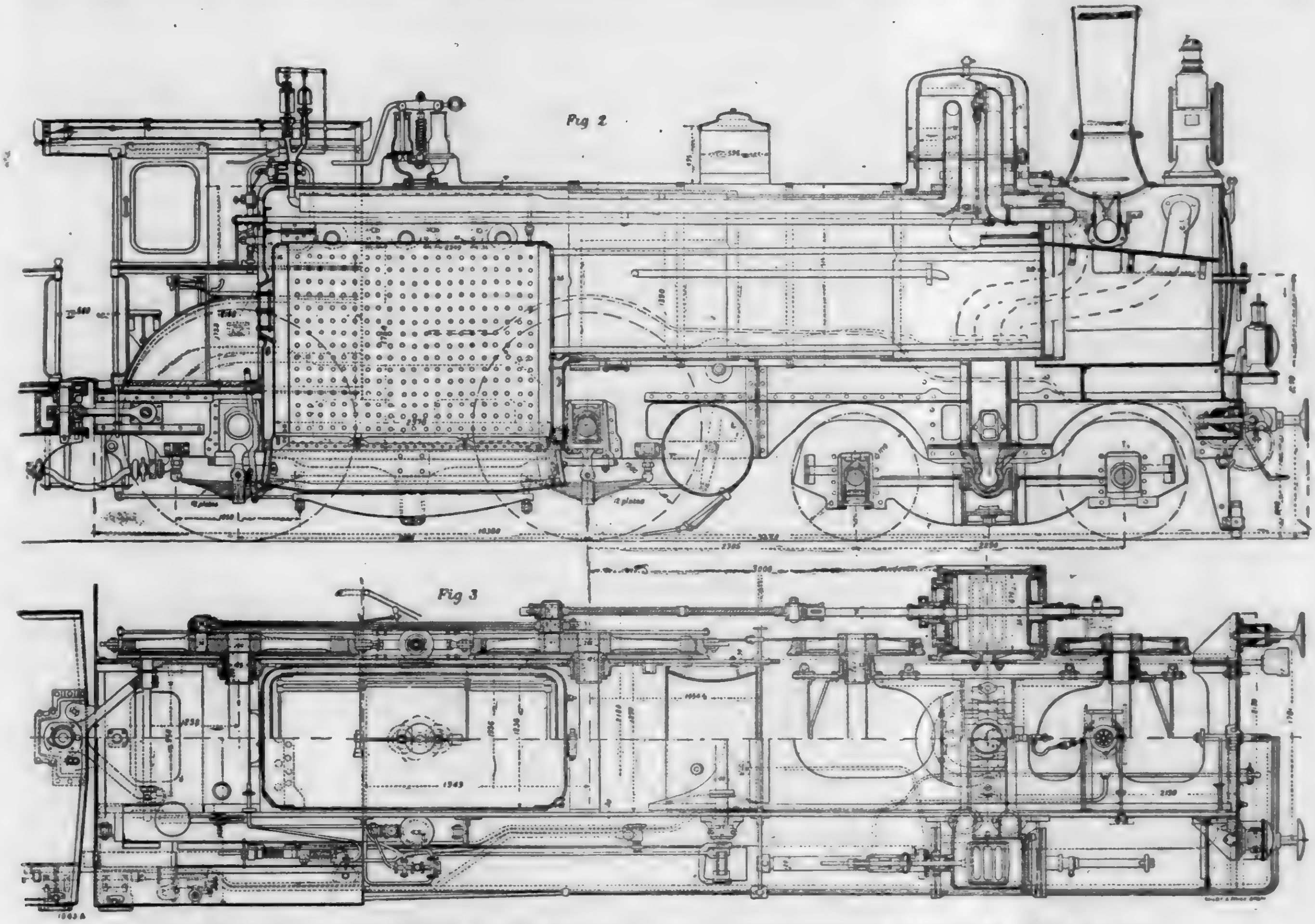
THE accompanying illustrations, from the London *Engineering*, show one of a number of compound locomotives for fast passenger service, built for the St. Petersburg-Warsaw Railroad, in Russia, by the Kolomna Works in St. Petersburg. The first illustration is a general view of the engine; fig. 2 is a longitudinal section; fig. 3, a plan; figs. 4 and 5 are cross sections. The engine is a two-cylinder compound of the eight-wheel American type, having four coupled wheels and a four-wheel truck; it presents some notable peculiarities of construction, having a mixture of European and American features in its design.

The boiler is built for a working pressure of 165 lbs. The barrel is 54.8 in. in diameter, and has 220 tubes 2 in. in diameter and 13.78 ft. long. The fire-box is 7.94 ft. × 3.53 ft. at the bottom, 7.71 ft. × 3.73 ft. at top and 5.76 ft. in depth. The crown-sheet is stayed direct to the outer



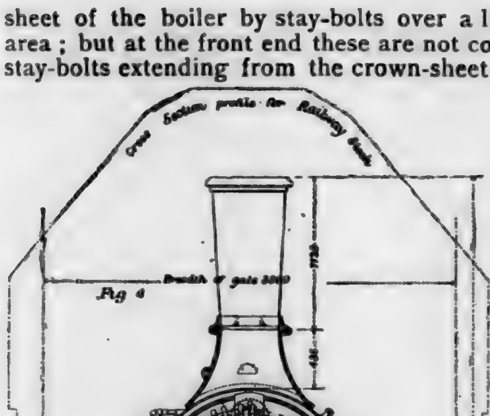
COMPOUND LOCOMOTIVE FOR FAST PASSENGER SERVICE, ST. PETERSBURG-WARSAW RAILROAD.

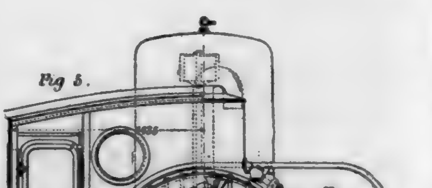
BUILT BY THE KOLOMNA WORKS, ST. PETERSBURG, RUSSIA.



COMPOUND PASSENGER LOCOMOTIVE, ST. PETERSBURG-WARSAW RAILROAD.

sheet of the boiler by stay-bolts over a large part of its area; but at the front end these are not continuous, short stay-bolts extending from the crown-sheet to a transverse bar, which in turn is stayed to the boiler shell by others. This arrangement is shown in figs. 2 and 5. Other transverse stays tie the sides of the shell above the fire-box, compensating for the strains thrown upon the shell by the direct stays.





There is an extended smoke-box 4.93 ft. in length. The boiler is long, 26.85 ft. over all. The grate area is 26.5 sq. ft.; the heating surface is: Fire-box, 134.6; tubes, 1,437.4; total, 1,572 sq. ft. The fuel used is wood. With the water 4 in. above the crown-sheet the boiler will hold 160 cub. ft. of water, and has a steam-space above the water of 73 cub. ft. The center of the boiler is 7.47 ft. above the rails, and the top of the chimney is 17 ft.

The driving-wheels are 78 in. in diameter, and the driving-axle journals are $7\frac{1}{4} \times 10\frac{1}{4}$ in. The truck wheels are $43\frac{3}{4}$ in. in diameter, and the truck axle bearings are $6\frac{1}{2} \times 10\frac{1}{4}$ in. in size. The truck axles are 7.57 ft. between centers, and the distance from center of truck to center of forward driving-axle is 11.61 ft. The driving-axles are well spread, being 9.83 ft. between centers. The truck is set well back, and the long smoke-box projects well over the forward wheels. The truck is of the swing-bolster type, and has a plate frame.

The high-pressure cylinder is 18.13 in. and the low-pressure 26.38 in. in diameter, both being 25.57 in. stroke. The ratio of the two cylinders is 1 : 2.12. The connecting-rods are 6.89 ft. long. The high-pressure cylinder has steam ports 11.81×1.78 in. and exhaust ports 11.81×3.38 in.; its valve has $1\frac{1}{8}$ in. outside lap and $\frac{5}{32}$ in. inside lap. The low-pressure cylinder steam ports are 20.50×1.78 in. and its exhaust ports 20.50×3.38 in.; its valve has $1\frac{1}{8}$ in. outside lap and no inside lap. Both valves are given $\frac{5}{16}$ in. lead. They are driven by the Joy valve gear. The

steam-chests are on top of the cylinders, and the slide-valves are of the Allen type.

It will be noted that the steam-pipes leading to the steam-chest are almost entirely outside the smoke-box. To prevent too great loss of heat by radiation they are covered by a sheet-iron casing, which gives the front end of the engine a curious boxed-in appearance to our eyes.

The total length of the locomotive is 34.03 ft.; engine and tender together are 57.28 ft. long over all. In working order this engine weighs 50.6 tons, of which 26 tons are carried on the driving-wheels.

The frames are of the plate type. At the front the frames are stayed together by horizontal plate stays in addition to the usual vertical braces, making the front end of the engine very rigid. The cylinders are bolted to the frames at the point where the cross-braces carrying the truck center-plate are fixed. The form of the truck center, which is of cast iron, is shown in the engravings.

The engine is provided with a steam sanding apparatus, a speed indicator, and the Wenger automatic brake. It has two whistles—a large one for use on the road and one with a lighter tone for use in stations and yards.

The tender can carry 13.8 tons of water in the tank, and the fuel-space will hold 472 cub. ft. of wood. It weighs 34 tons when fully loaded.

These engines have larger drivers than is usual on Russian railroads, where there are few or none over 6 ft. in diameter, and 66 in. is a more usual size for passenger service. The trains on the St. Petersburg-Warsaw line are heavy as a rule, and run at high speed; and these new engines are built to meet the requirements of this service, which the locomotives now in use are hardly able to do properly. The use of the compound engine for fast passenger service is also comparatively new in Russia, although a number of compound locomotives have been employed for some time in freight service on the Southwestern, the Griasi-Tzaritzin and other roads.

CONGRESSES AT THE COLUMBIAN EXPOSITION.

CONGRESS OF ENGINEERING SCHOOLS.

In addition to the other meetings to be held at Chicago next year, the Exposition seemed an excellent opportunity to bring together persons interested in Engineering Schools, the object being not simply a conference of professors among themselves, but a conference with practicing engineers, and the obtaining of suggestions from those who have had experience in the field. After consultation among a number of persons interested, a Committee has been formed to arrange for such a conference in combination with the World's Congress Auxiliary. This Committee has for its Chairman, Professor I. O. Baker, of the University of Illinois, and for its other members Professors W. T. Eddy, William R. Hoag, Samuel R. Stratton, Storm Bull and M. E. Cooley. It is hoped that teachers of engineering throughout the country will take part in presenting papers and by discussion. The Chairman of the Committee presents some suggestions for the list of subjects to be discussed, which are as follows:

1. Present state of engineering education (for as many countries as possible).

a. Historical outline as to origin, age, grade and support of the schools and colleges giving engineering edcation.

b. Qualifications for admittance.

c. Courses of study in civil, mechanical, mining, military and naval engineering.

d. Equipment.

e. Laboratory work and field practice.

2. The ideal engineering education.

3. Maximum and minimum mathematics necessary for an engineering education.

4. Modern languages in collegiate engineering courses of study.

5. How many weeks per year, how many days per week, and how many hours per day should a student give to collegiate work?

6. Present favorable and unfavorable tendencies of engineering education in America.

7. Engineering education and the State.

8. The relation between original research and engineering education.

9. Views of practicing engineers as to the needs of engineering education.

10. Comparison of engineering education at home and abroad.

11. Drawing and shop work.

Additional suggestions have been made by Professor Hoag to cover:

1. Vacation work.

2. Degrees conferred; desirability of uniformity.

3. Graduation thesis.

4. Technical essays.

The Committee, we understand, solicits suggestions which will aid in forming a programme.

CONGRESS ON RAILROAD COMMERCE.

Some time since a committee of the World's Congress Auxiliary of the Columbian Exposition was appointed having in charge the subject of Railroad Commerce. This Committee was made up of gentlemen well known in the railroad world as follows: Chairman, George R. Blanchard; Secretary, H. R. Hobart; A. F. Walker, E. T. Jeffery, John Newell, Edwin Walker, M. M. Kirkman, John W. Cary and George B. Reeve. This Committee has prepared an address which explains itself and the substance of which we give below:

Among the international congresses to be held at Chicago during the six months' season of the World's Columbian Exposition of 1893, is one on the subject of railroad commerce. It is proposed to convene on that occasion the leading representatives of the railroad interests of all countries, for mutual acquaintance and the consideration of the means by which their common interests may be promoted and their general welfare advanced.

Among all the subjects which now deservedly attract public attention none can exceed in importance that of the transportation of the products in the exchange of which commercial activity exists, and without which the great affairs of civilized life could not be conducted nor even preserved. The creation of the railroad world is so recent; its development and progress have been so rapid and so vast; the interests which it embraces are so varied and so extensive, touching the welfare of millions of people on the one hand and some of the most important operations of government on the other, that a proposal to consider these great themes in a world's congress of railroad representatives justly deserves and will undoubtedly receive the respect and attention, not only of railroad men, but also to a considerable extent of producers, manufacturers and merchants throughout the world.

The developments of the railroad business have been so rapid; experiments in railroad transportation have been tried in so many localities and under so many different classes of circumstances; and the results of different experiments have so many points of peculiar interest and importance, that there is obviously the highest propriety in convening those who have had the supervision and conduct of those experiments in a congress for the purpose of exchanging views, comparing results and proposing means by which their mutual interests may be advanced.

A few important facts will emphasize this position. The railroad mileage of the world at the commencement of 1892 was about 395,000 miles, representing a capital which may be estimated on the basis of the latest returns, at about $25,000,000,000. The United States has now over 171,000 miles of railroad, representing a capital of more than $11,000,000,000. The railroad employés of the United States number about 850,000 men, and the railroad employés throughout the world would form an army of at least 4,000,000. Every year, according to the average of the last five years, nearly 14,000 miles of railroad lines have been built in this and other countries, and when the World's Columbian Exposition shall open, the total mileage of the main railroad lines of the globe will be at least 410,000 miles. It might be supposed that railroad statis-

tics of the different countries have been collected from year to year, and are readily accessible to all who desire to use them; but this is by no means the case. On many important points the most valuable statistics are lacking in whole or in part. One of the benefits to be anticipated from the world's railroad commerce congress is the adoption of a world-wide plan for the collection, classification, and exchange of statistics in relation to railroad mileage, capitalization, equipment, number of employés, and other important relations of railroad commerce.

Another subject of immense importance to both the railroad companies and the general public, is that of State and national laws for the regulation of railroads in their relation to the people, to each other, and to their employés. The deliberate and thoughtful consideration of the practical results of governmental regulation and supervision; of the question whether such supervision should be restricted or extended; of the best means of preventing and of settling conflicts between railroad companies and their employés, and various kindred subjects, would excite an interest as deep and as widespread as may be anticipated for any other subject which will be presented at any other congress embraced in the entire series.

Such a congress would naturally embrace the railroad commissioners of the various participating States and Nations, as well as representatives of various railroad corporations. Such State and national commissioners might appropriately be convened under the leadership of the Interstate Commerce Commission of the United States, and facilities will of course be afforded for meetings of such commissioners apart from as well as in connection with the representatives of railway companies. Opportunity will be given for a comparison of the methods and results of railroad regulation in various countries as presented by governmental officials, in contradistinction to the presentation to be made by railroad officials.

To indicate the general scope and purposes of the proposed Railroad Commerce Congress the following themes, suggested by the President of the Auxiliary in organizing the Department of Commerce and Finance, are here given for the purpose of eliciting from all who may be interested the recommendation of such additional or different topics as may be deemed proper for the occasion:

a. The origin, development and present condition of railroad commerce in different parts of the world.

b. The influence of railroad commerce on the settlement and development of new countries.

c. The practical results of railroad commerce to producers, carriers, and consumers.

d. The proper elements of the cost of safe and efficient service.

e. The practical effects of free competition in the construction and operation of railroad lines.

f. The proper protection of the public rights and interests involved in railroad commerce.

g. The proper protection of private rights and interests involved in railroad commerce.

h. Railroad strikes; what should be done in the way of prevention and control.

i. Railroad employés; what should be done for their protection and improvement.

j. Railroad accidents; their causes and the practicable safeguards against them.

k. Railroad receiverships; the practical lessons they teach.

l. Governmental regulations of transportation and practical results thereof.

m. Freight traffic; special contracts, limitations of common law liabilities, railroad clearing houses, traffic pools, etc.

n. Baggage; checking systems and delivery; claims for damages, limitations of liability; restrictions of quantity, etc.

o. Passenger tickets; defects of existing systems; special contracts and conditions; limitations of time; through tickets; commutation tickets; zone tariffs, etc.

p. Police powers of railroad-train officials, and the best means of guarding against frauds on the carrier and against injury to passengers through accident or mistake.

q. Interstate and international railroad arrangements; their practicability; the best means for their promotion and their influence on the commerce, peace and prosperity of the world.

The subject of railroad construction, equipment and operation has been assigned to the department of engineering, and will there be considered in detail. It was thought important to relieve the railroad commerce congress of these topics, in order that the immense public and private interests involved in the subject of railroad commerce may have undivided attention.

The congresses of the Department of Commerce and Finance will commence June 19, 1893. The meetings will be held in the World's Congress Art Palace, now in process of erection on the lake front park at Chicago, in which there will be two large audience rooms capable of seating 3,000 persons each, and more than 20 smaller rooms for meeting of chapters and sections. These places of meeting will be furnished free of expense, for the various congresses.

Each congress is in charge of a local committee of arrangements, and this committee will be assisted by an advisory council selected from all of the various participating countries, and consisting of the most eminent representatives of the interests involved. The advisory council of the Railroad Commerce Congress will be selected and announced as soon as practicable, and in the mean time the State and national commissioners or other officials of all countries, and the officers of railroad corporations throughout the world, are cordially invited to furnish the above-mentioned committee at their earliest convenience with their suggestions of the themes which it would be most useful to consider in the proposed congress, of the persons by whom such themes may most advantageously be presented, and of the modes of proceeding by which the most satisfactory and useful results may be secured.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(Continued from page 465.)

Fig. 52 exhibits an apparatus patented in 1871 by M. *Danjard.* This was to consist in parachute-like sails in front and at the rear, between which were to be placed two sustaining aeroplanes, between which again there was to be a pair of vibrating wings, which, in connection with

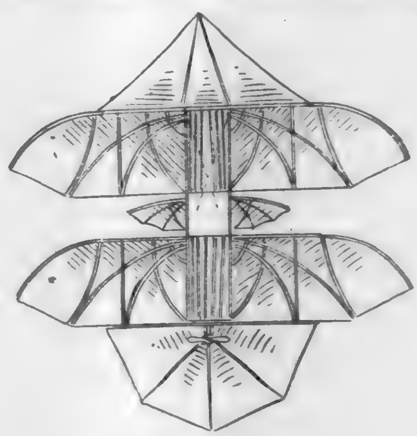


Fig. 52.—DANJARD—1871.

a screw, placed behind the car, were to furnish the impulsion. The front parachute was to be triangular in form, and made strong and rigid to cleave the air; while the rear parachute and the two aeroplanes were to be made flexible in the rear, so as to obtain a horizontal thrust from the escaping air compressed at the front. Under the rear parachute there was to be a rudder, to move to the right or to the left, and the machinery and aviators were to be in the central car. No motor is indicated save hand-power, but, of course, any primary motor could be applied if it were only light enough.

The apparatus is not known to have been experimented with. Probably M. *Danjard* dropped a lot of paper models and found that the arrangement of planes in pairs was more stable than a single aeroplane, and the figure is here given to show a combination which will be seen to have given fair stability in other experiments to be hereafter described.

The next experiment to be mentioned was important and quite successful upon the small scale on which it was tried. Fig. 53 represents an aeroplane with automatic equilibrium, produced in 1871 by M. *A. Pénaud*, who called it his "planophore," and whose artificial bird and flying screw have already been noticed.

The motive power in this aeroplane was, as in his former models, the force of twisted india-rubber threads, fastened to a stick 20 in. long, and rotating a double-vaned screw

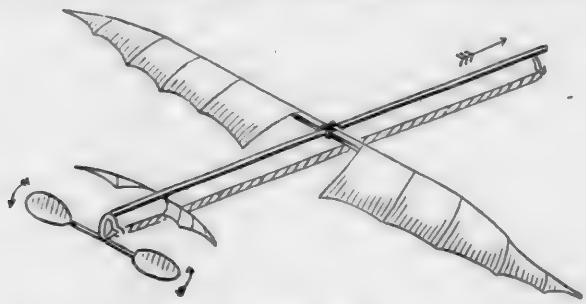


FIG. 53.—PÉNAUD—1871.

8 in. in diameter. The aeroplane, 18 in. across, by a width of 4 in., was fastened to the main stick at about its center, so that, through the leverage of the front end, the center of gravity of the apparatus should be slightly in front of the center of surface of the sustaining aeroplane. The outer ends of the latter were bent upward, so as to furnish lateral stability by a diedral angle, and the longitudinal stability was secured by fastening to the main stick, back of the aeroplane, as shown, a small pair of wings or rudders, set at an angle of about 8° pointing below the horizon of the main aeroplane.

This was the important feature of the apparatus, and M. *Pénaud* not only showed experimentally that it furnished automatic equilibrium, but he also demonstrated* the mathematical reasons why it should do so, in reestablishing, through the action of the air impinging upon this horizontal rudder set at a fixed angle, any deviation of the aeroplane from the horizontal line of flight. The principle is the same as that of the rear fold of the paper aeroplane which has already been described, and the following account of its mode of action was given by Mr. Bennett at the 1874 meeting of the Aeronautical Society of Great Britain:

The center of gravity of the machine is placed a little in front of the center of pressure of the aeroplane, so that it tends to make the model descend an incline; but in so doing it lessens the angle of inclination of the aeroplane, and the speed is increased. At the same time the angle of the horizontal rudder is increased, and the pressure of the air on its upper surface causes it to descend; but as the machine tends to turn round its center of gravity, the front part is raised and brought back to the horizontal position. If, owing to the momentum gained during the descent, the machine still tends upward, the angle of the plane is increased, and the speed decreased. The angle of the rudder from the horizontal being reduced, it no longer receives the pressure of air on its superior surface, the weight in front reasserts its power, and the machine descends. Thus, by the alternate action of the weight in front and the rudder behind the plane, the equilibrium is maintained. The machine during flight, owing to the above causes, describes a series of ascents and descents after the manner of a sparrow.

The weight of the entire apparatus was 0.56 oz., of which the rubber absorbed 0.17 oz., or about one-third. The surface was 0.53 sq. ft., so that the proportion was nearly at the rate of 15 sq. ft. per pound, and necessarily gave a slow flight.

The apparatus was publicly exhibited in August, 1871, to a group of members of the French Society of Aerial Navigation, in the garden of the Tuileries, and the model, guided horizontally by a small vertical rudder, not shown on the figure, flew several times in a circle, falling gently to the ground near its starting-point, when the power of the rubber was exhausted. The speed was not quite 12 ft. per second, or about the same as that of insects with the same relative surface in proportion to their weight, and the flight was 131 ft. in 11 seconds, with 240 turns of the rubber.

Subsequently M. *Pénaud* measured the power consumed in a very ingenious way. He found that with 60 turns of the rubber the apparatus would just hold its own—*i.e.*, hover in the same spot, against a wind of 9 ft. per second, and knowing the speed of rotation of the screw, as well as the weight of the apparatus, he deduced the conclusion that the power expended was at the rate of one horse-power for each 81 lbs. of weight, although M. *Touche*, who has revised the calculations, makes it about three times this amount—a result, of course, quite inferior to those obtained by Professor Langley and by Mr. Maxim, because, perhaps, of the greater proportion of surface to weight.

M. *Pénaud* was a very ingenious man, and might have accomplished great things in aerial navigation had not his career been cut short prematurely. He was one of the few men who have taken up the subject in his youth, for it is a singular fact that most of the scientific students of this inchoate research are now men of middle age, perhaps past the dread of being considered mentally unsound, but no longer with the ardor and the daring of youth. M. *Pénaud*, however, began before he was 20 years old, by producing his flying screw. He had intended to enter the French Navy, but a painful hip disease had brought him to crutches, and left him no career but that of scientific studies. These he directed to aerial navigation, and during six or seven years of improved health he impetuously investigated and experimented upon the various phases of the problem. Not only did he produce the three forms of apparatus which have been described, almost the first which have practically worked, each flying upon a different principle and all produced by one man, but he took a very active part in the investigations promoted by the French Society for Aerial Navigation; making a scientific balloon ascent, in which he was somewhat injured, designing a plane table for platting the course of balloons, a guide rope break, a delicate barometer, a balloon-valve, a kite without a tail, balanced in the same way as his aeroplane, a form of explosion engine, a programme for experiments on air resistances, one for investigation of flight by instantaneous photography, since carried out by Professor Marey, etc., etc., towering above his fellow-members in discussions, in a way which must have excited many jealousies; and he also contributed a number of very valuable papers to the *Aéronaute*, in one of which he endeavored to account for the mystery of sailing flight by showing that ascending currents in the wind were not rare, and were quite sufficient to explain all the phenomena.

These labors finally culminated in his taking, in 1876 (in partnership with M. *Gauchot*, a clever mechanician, who had produced an artificial bird), a patent for the apparatus shown in fig. 54, which was to be of sufficient size to carry up two men.

It was to consist of an aeroplane somewhat in the form of an ellipse, built of a light framework covered both at top and bottom with varnished silk, and stiffened by wire stays radiating from two short masts above and from the car below the aeroplane. The outer ends of the aeroplane were to be flexible, or to be set at a diedral angle, in order to produce lateral stability, and the rear portion was also to be flexible and to bend upward, to produce the longitudinal stability, this being, moreover, provided for by two horizontal rudders, side by side, hinged at the rear, so as to set themselves automatically at the angle required to produce fore-and-aft equilibrium, upon the principle developed in the "planophore." Under these balanced horizontal rudders a vertical rudder was to steer to the right or left. A car, in the shape of a light boat, was to be rigidly attached just under the aeroplane, the steersman standing or sitting at the bow, with his head just above the top of the aeroplane, and protected from the

* *Aéronaute*, January, 1872. Page 4.

wind by a glass box. Movable legs with rollers and springs were to be let down to get a preliminary run on land, or to alight in a glancing direction.

The motion was to be obtained from two propellers, placed at the front edge of the aeroplane, and rotating in opposite directions; the power to be furnished by a steam-engine—although M. *Pénaud* said frankly that he knew of none in practical operation sufficiently light for his purpose. He believed it ought not to weigh more than 15 to 22 lbs. per horse-power, and hoped to get one constructed within those limits. The engine was so to be located in

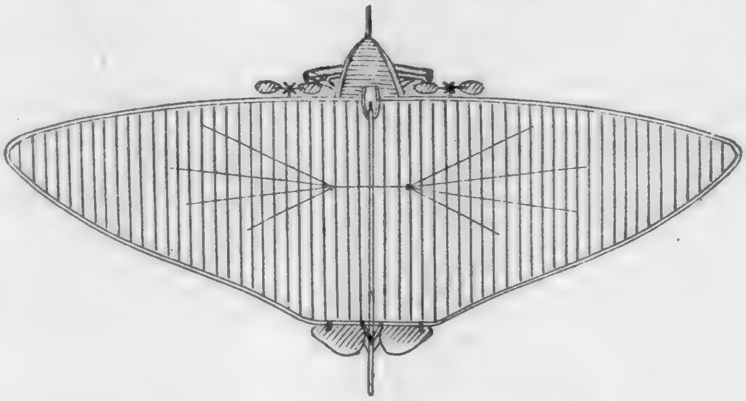


FIG. 54.—PÉNAUD & GAUCHOT—1876.

the car as to bring the center of gravity of the apparatus one-fifth of the distance back of the front edge, and all the steering was to be done by the helmsman through a single lever, which might either be pulled or pushed to work the horizontal rudders, or twisted to work the vertical rudder.

The sustaining surface of the aeroplane was to be proportioned at the rate of about 0.24 sq. ft. per pound of weight, the whole apparatus with two aviators was to weigh 2,640 lbs., and required an engine of 20 to 30 H.P. to fly through the air at 60 miles per hour, with an angle of incidence of 2°.

This apparatus, the result of several years of study by an able man who bestowed very careful thought thereon, was never built. The writer of this does not believe it would have succeeded if it had been experimented with, but valuable data might have been obtained. Aside from the difficulty about a light motive power, a difficulty now almost removed, it may be questioned whether the general form of the aeroplane was the best possible to glide upon the air, and whether the longitudinal equilibrium would have been as well preserved as in M. *Pénaud's* toy model. If not, then a sustaining surface of only 0.24 sq. ft. per pound would have been exceedingly dangerous. The horizontal rudders, when left to adjust themselves, were expected to regulate the automatic balance, but they were also expected, when actuated by the steersman, to alter the angle of incidence, in order to cause the apparatus to rise or to fall. Such a change in the angle would necessarily alter the position of the center of pressure, and there was no provision for making a corresponding change in the center of gravity, other than by the displacement of the aviators themselves, or that of the fuel, water, or boiler, which displacement would be nearly impracticable. This was the weak point, for the pressure being then applied at a point differing from the center of gravity, would act with a leverage upon the apparatus and tilt it either forward or backward longitudinally, so that, had it been experimented with on a practical scale, it might have experienced a forward sheer or a plunge, either from too great an action of the horizontal rudders in rising or in coming down, or, as in the case of poor *Le Bris's* second experiment, from encounter with a stratum of wind of different horizontal direction than that for which the machine was adjusted.

Perhaps surmising the possibility of some such action, M. *Pénaud* suggested that the experiments should be conducted over a sheet of water. The apparatus might also have been suspended between two very high masts, or from a captive balloon, but probably the best results would have been obtained by experimenting entirely clear of any restraining supports.

At any rate no funds were forthcoming for the construction of the full-sized machine. M. *Pénaud* was criticised, decried, misrepresented, and all sorts of obstacles arose to prevent the testing of his project. He lost courage and hope, his health gave way, and he died in October, 1880, before he had reached 30 years of age.

He had doubtless done much toward solving the difficult problem of automatic stability in the air, but the French aviators do not seem to accept M. *Pénaud's* device as a solution of the question of longitudinal equilibrium. They claim that it consumes too much power in the constant readjustment of the stability, and that in a full-sized navigable apparatus it would not act quickly enough to prevent disaster. In September, 1890, M. *Hureau de Villeneuve* published a paper in the *Aëronaute*, in which he treats the problem of stability as yet to be solved, and suggests the inverted cone, as exemplified in the parachute of Cocking (which failed simply by reason of faulty construction), and he proposes as a possible solution of the equilibrium in both directions, that the aviating surface shall be made to conform to the development of an inverted cone. That is to say, that its lines, whatever they may be in the ground plan, shall in vertical projection follow the development of an inverted cone, placing the center of gravity so as to correspond with the position of the apex, and this he seems to have illustrated with a number of working models by cutting out various forms of birds out of an inverted cone.

Pénaud said that his solution was practically the same as that of Sir *George Cayley*, with whose labors he was not acquainted at the time that he hit upon the device for his "planophore." In his articles in *Nicholson's Journal*, published in 1809 and 1810, Sir *George Cayley* shows that the lateral stability is easily secured by placing the wings, either curved or plane, at a slight diedral angle to each other, and he lays down the principle, that in order to secure the longitudinal stability: 1. The center of gravity must be made to occupy a position directly under the center of pressure; and 2. The aeroplane requires, to steady it, a rudder in a similar position to the tail in the bird. He then continues:

> All these principles upon which the support, steadiness, elevation, depression, and steerage of vessels for aerial navigation depend have been abundantly verified by experiments, both upon a large and small scale. I made a machine having a surface of 300 sq. ft., which was accidentally broken before there was an opportunity of trying the effect of the propelling apparatus, but its steerage and steadiness were perfectly proved, and it would sail obliquely downward in any direction according to the set of the rudder. Its weight was 56 lbs., and it was loaded with 84 lbs., thus making a total of 140 lbs., or about 2 sq. ft. to 1 lb. Even in this state, when any person ran forward in it with his full speed, taking advantage of a gentle breeze in front, it would bear upward so strongly as scarcely to allow him to touch the ground, and would frequently lift him up and convey him several yards together. . . . It was beautiful to see this noble white bird sail majestically from the top of a hill to any given point of the plain below it, with perfect steadiness and safety, according to the set of its rudder, merely by its own weight, descending in an angle of about 8° with the horizon.

A number of very interesting experiments upon the stability of aeroplanes were tried in 1873 and 1874 by Mr. *D. S. Brown*. He had begun by seeking for a light motive power, and his proposal for a steam-engine with an india-rubber bag instead of a cylinder has already been noticed; but becoming aware of the enormous importance of stable equilibrium, he turned his attention in that direction. He exhibited at the meeting of the Aeronautical Society of Great Britain, in 1873, a model consisting of two planes of equal size, one placed before the other at some distance and connected by a rod, which arrangement showed much greater stability than a single plane, and he followed this up at the next meeting, in 1874, by exhibiting models of what he called his "aero-bi-plane," which showed still further improvement in the stability, in consequence of

"constructing the anterior edges or frames of the planes rigid, and the other parts yielding or elastic." The two planes might be rectangular and have their anterior edges straight, or these might be curved to diminish the air resistance, and the surfaces were placed one behind the other in the same general plane, so that they did not, as in the case of *Pénaud's* "planophore," make a slight horizontal angle with each other.

Mr. *Brown* stated that "the aeroplane should not be inclined to its path of motion, but its surface should form a direct line with it. . . . the plane being kept at the same elevation by slightly directing its course upward, sufficient to compensate for any fall which may take place." As, however, there was in the model a horizontal rudder, which regulated the angle of incidence in flight, Mr. *Moy* pointed out that the claim was a distinction without a difference. In one model the planes were connected with each other through double rods, so as to admit of a load, representing a car, being placed between them, and Mr. *Brown* stated that in this form it might be termed a progressive parachute, which was only supported by the air when in forward motion. When this motion was stopped—and this might be done by bringing it suddenly into a large angle with the horizon, so as to increase the resisting surface—the model settled down to the floor. It being, therefore, necessary that the apparatus should start with an initial motion, this was given by an india-rubber rope fastened at one end to a post, and at the other, by means of a ring, to a vertical bolt inserted in the under part of the bi plane, so that it might be released when the rope slackened. The experiments are described in the report of the meeting as follows :

> Mr. *Brown* launched several planes of different dimensions. All showed perfect stability, and, save one or two, floated in the air in a horizontal position across the room, a distance of between 20 and 30 ft., and, apparently, in some instances could have gone further without falling had not the walls intervened. One he suddenly pressed downward in a perpendicular direction by striking it with a stick when in the air ; this caused it to dart forward with great velocity in a horizontal course. Mr. *Brown* considered this an illustration of true flight, as the planes were only inclined the moment he struck the connecting-rod. During the flight they recovered their horizontal position and offered no resistance to the air.

It may be noticed that this arrangement of surfaces, which Mr. *Brown* referred to as "first steps to flight," differs from that of M. *Pénaud* in making the rear plane of the same size as that of the front, and parallel therewith, the automatic stability being obtained through the flexibility of the posterior edge, which acts much in the same way as the upward inclination of the rear plane or rudder in *Pénaud's* apparatus. Whether either of these arrangements, thus slightly differing in construction, will prove adequate in practical operation upon a large scale, can only be ascertained by experiment, but it may be stated that the British aviators have not accepted Mr. *Brown's* proposal as a solution of the problem of equilibrium, and that some of them believe that he made a mistake in placing his planes parallel with each other ; "no change of action taking place whether the planes move from the horizontal to 45° or to any other angle."

The next apparatus to be noticed will be found described in most of the articles on flight in magazines and in encyclopædias, but the writer of these lines has been fortunate enough to obtain from Mr. *Moy* himself still further particulars concerning an experiment which has well been characterized in the reports of the Aeronautical Society of Great Britain as "one of the most determined attempts at solving the problem which has yet taken place."

Fig. 55 shows a front view, from a photograph, of "Thomas Moy's aerial steamer," which was tried in the open air at the Crystal Palace near London in June, 1875. The supporting surfaces consisted in two aeroplanes, one in front and the other behind the propelling aerial wheels ; the planes being of linen, stretched upon bamboo canes, and set at an angle of 10° with the horizon, the rear plane being placed higher than the front plane, but parallel therewith. A third steering plane, of smaller size, governed by a horizontal wind wheel with screw vanes, was placed in the rear to serve as a horizontal rudder. The front plane measured 50 sq. ft., and the after plane had 64 sq. ft. of surface ; their true size in relation to the whole apparatus being inadequately shown in the figure, because of the perspective, as they are seen nearly edgewise.

Between the two supporting aeroplanes were placed two propelling aerial wheels 6 ft. in diameter, each provided with six blades. These were first made of thin laths to approximate to true helices, but were afterward made of Scotch cambric. The blades or vanes were by a most

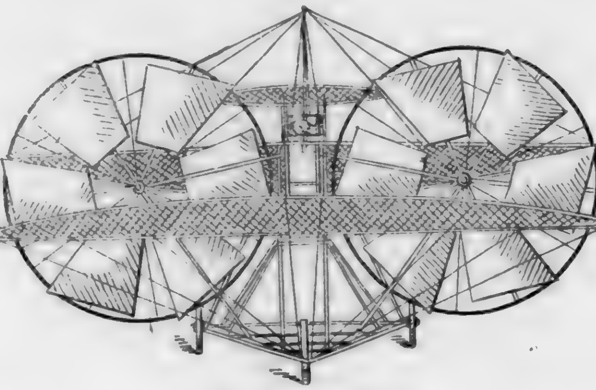


FIG. 55.—MOY—1875.

ingenious and simple arrangement caused to change their angle of incidence as they rotated, so as to be "successively caused to be inclined to the line of onward motion of the machine, in such a manner that the blades on one side of the neutral line will be caused to act downward on the air with both a raising and propelling effect, while those on the other side thereof will, in their upward course, be impinged upon by the air with only a lifting tendency." This being in effect an aerial screw in which the pitch was variable in every portion of the revolution, and constituting the chief feature of novelty in the whole apparatus.

The steam-engine was placed between the two aerial wheels, and was a marvel of lightness. The diameter of the cylinder was 2¼ in. and the stroke 3 in., with 520 to 550 revolutions per minute. The heating surface was 8 sq. ft. or 2⅔ sq. ft. per horse-power, the boiler being of the water-tube description, and the steam pressure was 120 to 160 lbs. per square inch, the fuel being liquid and burned in Russian lamps. The engine weighed, with the boiler, 80 lbs. and developed fully 3 H.P., being at the rate of 26⅔ lbs. per horse-power, or about the same as the 1868 engine of Mr. *Stringfellow* as rated by himself. Mr. *Shill*, a clever mechanician, who exhibited a remarkably light engine in 1868, was associated with Mr. *Moy* in producing the 1875 engine, and had an interest in the patents, so that the apparatus was also known as the "Moy & Shill aerial steamer." It was 14 ft. long and about 14 ft. wide, was mounted on three wheels, and weighed 216 lbs., thus being proportioned at the rate of 0.53 sq. ft. of sustaining surface per pound of weight, omitting the lifting effect of the aerial wheels, which measured 60 sq. ft. more.

The inventor estimated that at a speed of 35 miles per hour the apparatus would be able to rise from the ground and glide upon the air, and this estimate seems fully confirmed by Professor Langley's recent experiments, which show that the uplift on a plane surface of 114 sq. ft. at an angle of 10° would be fully 206 lbs., while somewhat higher results are obtained from the table of "lift" and "drift" heretofore given herein, when taken in connection with Smeaton's table of wind pressures.

After some preliminary tests a path around one of the fountains at the Crystal Palace was selected, which had a diameter of nearly 300 ft.; a pole was erected at the center of the fountain, and two cords were run from the top of the pole to each end of the machine, in order to keep it at a uniform distance from the center. The gravel had been rolled, and steam was got up. The gravel, however, proved too rough, it shook the steamer and largely increased the traction. Then a board walk was laid over

the path, and again steam was got up and a good run was made around the fountain, the machine (which was only a large model and could not carry an engineer) being wholly propelled by the action of the aerial wheels upon the air, acting only as drivers.

The utmost speed attained was 12 miles per hour, while 35 miles an hour was required to cause it to leave the ground. This indicated that the resistances had been underestimated, which resistances consisted in the traction upon the boards, the air resistance on the framing, cordage and ground wheels, and also in the "drift" due to the inclination of the sustaining planes. With our present knowledge we can say that at a speed of 35 miles per hour (6 lbs. per sq. ft.) the latter would have been : $114 \times 6 \times 0.0585 = 40$ lbs., and as the speed would have been 3,080 ft. per minute, the power required by the "drift" was : $\frac{40 \times 3080}{33.000} = 3.73$ H.P., to say nothing of the other elements of resistance, so that it is not strange that only 12 miles an hour was attained.

Mr. *Moy* needlessly handicapped himself in starting from the ground by a level run. He reasoned, like many others before and since, that "when they were coming down power was wanted, and, of course, power was especially wanted when they were going up," but he encountered thereby, in an experimental machine, all the additional resistance of the traction upon the boards. He considered the propriety of launching the apparatus from a height, or down an incline, but then this costly machine, built wholly at his own expense, would surely have come to grief, for he says that "the transverse stability was better than the longitudinal stability, but both were bad," and unless this was first remedied, it really was not safe to experiment.

Mr. *Moy* also placed his sustaining aeroplanes at too obtuse an angle, for if he had simply doubled their area, and inclined them at 5° instead of 10°, the "lift" would have been, by the table, at 35 miles per hour : $228 \times 6 \times 0.173 = 236$ lbs., or practically the same as before, but the "drift" would have been diminished to : $228 \times 6 \times 0.0152 = 20.79$ lbs., or about one half of that heretofore calculated.

Such experiments would doubtless have been tried had ample means been forthcoming, but other things were more pressing, for it was recognized that some modifications would be required in the steam generator, which was provided with six Russian lamps burning methylated spirits, and it was found that when running in the open air, the fumes from the three forward lamps extinguished the three after lamps, and thus reduced the power one-half. Before even this difficulty could be remedied the machine was seriously injured by the wrecking of the bamboo aeroplane frames, while it was being moved *stern first* across the grounds, in a fierce gale, and Mr. *Moy* then decided to rearrange it for experiment, as to its vertical lifting power, by substituting 12-ft. aerial wheels with vertical axles tried under cover.

The total surface of these new aerial wheels was 160 sq. ft., and the weight, including engine, boiler and all accessories, was 186 lbs. It was found that by counter-balancing 66 lbs. with levers, the wheels would lift the remaining 120 lbs., thus showing a lift of 40 lbs. per H.P., or about the same as the best performance which has been attained with other forms of screws.

Mr. *Moy*, as the result of his various experiments, then proposed to build a much larger apparatus, with an engine of 100 H.P., and capable of carrying several men, both to avail of the diminished relative weight and resistance of larger engines and to secure intelligent control while in action ; but the money could not be secured for this purpose. It would necessarily have cost a large sum, and at that time (1875) not only was the whole subject of aerial navigation generally considered as visionary, but there was not sufficient knowledge to enable the public, or even scientific men, to distinguish the difference between a wild proposal, sure to fail to compass flight, and a promising experiment which was worth following up—a condition of affairs which has in a measure continued to this day, and which this account of "Progress in Flying Machines" is partly written to remedy.

So Mr. *Moy* got no money, but he had instead "two chancery suits about shares in his patents, with no help from any one ;" his experiments had brought him down in funds, and he had to turn to hard work to live. As he justly remarks, "Unless you can lift the last ounce of a model, the unscientific people call it a failure, and few can appreciate that as size and weight increase, the relative hull resistance decreases, by reason of its diminished surface in proportion to its cubic contents." He, however, continued to take an active interest in the subject ; read papers at the meetings of the Aeronautical Society of Great Britain, made private experiments with planes, both in air and in water, as well as with methods for securing automatic stability, and with an improved method of propulsion.

In 1879 Mr. *Moy* exhibited at the meeting of the Aeronautical Society the small flying model shown in fig. 56, which he described as a "military kite" mounted upon wheels and provided with propelling gear. The front plane measured 660 sq. in. of surface, and the after plane, of

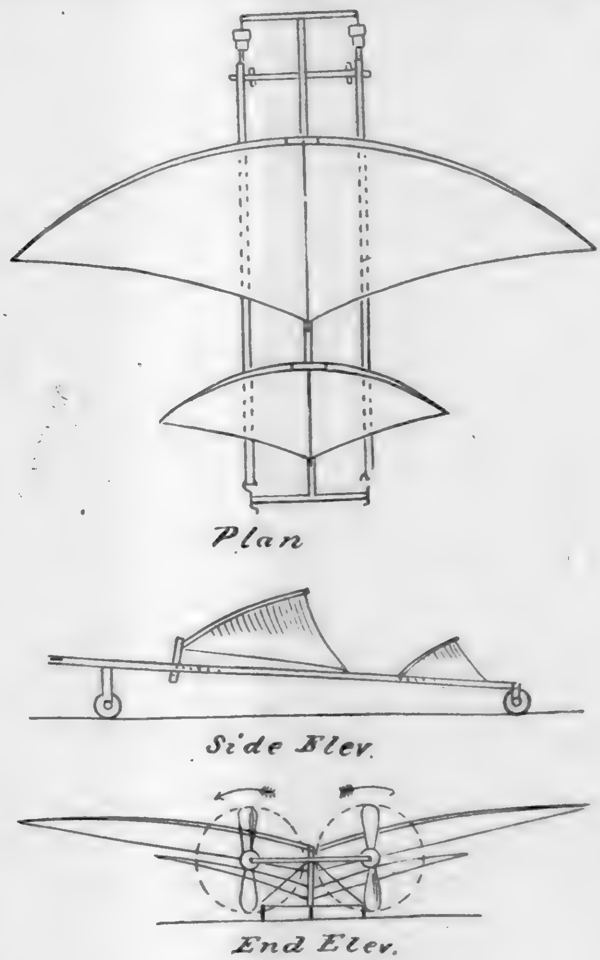


FIG. 56.—MOY—1879.

half its linear dimensions, measured 165 sq. in. They were made of cambric, fastened to a central box-girder of thin pine, running lengthways, and mounted on small wheels, the aeroplanes being given a diedral angle, as shown, and the angle of incidence fore and aft being adjustable. At each end of the central stick or box-girder cross-arms were fastened, which held in position strands of india-rubber strings, one on each side of the central stick and parallel therewith, the untwisting of which rotated (in opposite directions) two screw propellers with two vanes each. These propellers are removed in the plan and side view of fig. 56, for the sake of clearness, but are shown in the end elevation or front view.

The model weighed 24 oz., of which 3½ oz. was in the india-rubber springs, and with 500 turns of the rubber it would run on its wheels over a smooth surface, and under favorable circumstances would rise for a short distance upon the air. It would, of course, fly from the hand like

Pénaud's planophore, but showed, like it, great waste of power, the supporting surfaces being at the rate of 3.82 sq. ft. per pound, and the angle of incidence required for it to rise from the ground being 8°; and more unfavorable than a flatter angle, at which, however, it would not have possessed sufficient "lift." Mr. *Moy* says that "its transverse stability was very good, but its longitudinal stability was defective, and was a perfect puzzle at that time, but now all these troubles are overcome."

He has recently patented in England a method for automatically securing horizontal stability, and it is to be hoped that he will be enabled to renew his experiments.

Mr. *Moy* has also been an observer of soaring or "sailing" flight, and he described the sailing of the albatross in a wind, on rigid wings, in a paper read before the Aeronautical Society in 1869. Deeming it possible for man to imitate this performance, but recognizing the prodigious difficulty of reproducing the complicated shape and arrangement of curved surfaces (not planes), with which impulse is received from the wind, and of imitating the exquisite balancing through which the soaring birds perform this feat, he read a paper before the "Balloon Society," in 1884, in which he proposed an ingenious method of carrying on the many experiments required, with no greater danger than that of getting wet, by taking a start at sea from a lifeboat on the crest of the waves in a gale, equipped with a pair of wings and an inflated Boynton dress. In the hope that some aviator, favorably situated, may try this experiment, the paper, rewritten for the purpose, will be given in the appendix.

(TO BE CONTINUED.)

THE IMPROVEMENTS OF THE SAULT STE. MARIE CANAL.

(From the Cleveland *Marine Record.*)

At the Sault Ste. Marie the building of a new and larger lock is in progress, taking the site occupied by the two old locks built in 1855, the canal itself being deepened to correspond, so as to give a navigable depth of 20 ft. The dimensions of the new lock will be: Length 800 ft. between gates, width 100 ft. throughout, with 21 ft. of water on the sills, with a single lift, approximating 18 ft. The estimated cost of this new lock and work of canal deepening is set down at $4,738,865. For the fiscal year ending June 30, 1893, an additional sum of $2,000,000 can, it is stated, be profitably expended, in view of the importance of completing the work at the earliest possible date, the enormous traffic being now dependent on a single lock.

In connection with the enlargement of this canal, there has been undertaken, and is in progress, the work of improving the southern channel of the river below the falls, known as the Hay Lake Channel in United States waters. It is proposed to make a channel of 300 ft. wide, and of a navigable depth of 20 ft. The improved route will leave the present navigable channel of the river at a point Sugar Island Rapids, about 2½ miles below the canal; will pass through these into Hay Lake; then by way of Middle Neebish; rejoining the present navigable channel at the foot of Sugar Island; saving a distance of 11 miles (16 miles in place of 27), and giving a route which can be so marked by lights as to be navigable at night, an advantage which is not to be afforded by the present channel, except by the use of many lights. The estimated cost of the work is set down in the report of the U. S. Engineers at $2,659,115.

The Dominion Government has also entered into the construction of a large canal, and it is being rapidly constructed through St. Mary's Island, on the north side of the rapids. At ordinary stages of the river water, there is a difference of 18 ft. in the levels of the water above and below this island. The length of the canal across the island is 3,500 ft. A considerable amount of excavation is required to form channels of approach, both at the upper and at the lower entrances. The total length of this canal and its approaches will be about 18,100 ft. The plans for the Dominion canal lock, after several modifications and radical changes, are as follows: Length of chamber, 900 ft.; width of chamber, 60 ft.; gate width 60 ft.; depth of water on the sills, 19 ft. at the lowest recorded water level. This depth, though calculated on a different basis (extreme low instead of mean water level), is intended to be the equivalent of the depth, 21 ft., of the new American lock now under construction. By the scheme as modified, accommodation will be afforded to three vessels lying in the lock, one behind the other, one of the lake type 320 ft. long, and two of the Welland Canal type, 255 ft. long, with ready means of entrance and exit on a course through the gates and lock straight with the line of the canal. The canal proper will have a width at low water level of 152 ft., and a bottom width of 145 ft. The depth will be made suitable to navigation at mean water level by vessels drawing 20 ft., and the gates will be worked either by hydraulic power or by electricity.

THE LOCOMOTIVE PROBLEM AGAIN.

In the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Several answers were received to this and were published in the July, August and October numbers of the JOURNAL; since then some additional replies have been sent in, which are given below:

VIII.—BY D. E. HUGHES, C.E., IRVINGTON, CAL.

My solution of the Problem is as follows (see fig. 6):

$$b = \sqrt{c^2 - r^2 \sin.^2 \theta} + r \cos.\, \theta$$

$$\frac{\text{velocity cross-head}}{\text{velocity crank-pin}} = \frac{db}{r\,d\theta} = \frac{\sin.\, \theta \cos.\, \theta}{\sqrt{\frac{c^2}{r^2} - \sin.^2 \theta}} + \sin.\, \theta \quad (1)$$

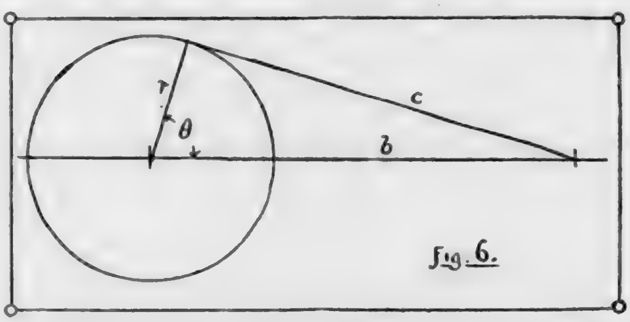


Fig. 6.

To find where this ratio is maximum, put the first derivative of (1) equal to zero, and solve for θ.

$$\frac{\sqrt{\frac{c^2}{r^2} - \sin.^2 \theta}\,(\cos.^2\theta - \sin.^2\theta) + \frac{\sin.^2 \theta \cos.^2 \theta}{\sqrt{\frac{c^2}{r^2} - \sin.^2 \theta}}}{\frac{c^2}{r^2} - \sin.^2 \theta} + \cos.\theta = 0. \quad (2)$$

Reducing (2),

$$\cos.^6 \theta + \left(\frac{c^2}{r} - 3\right) \cos.^4 \theta - \left(\frac{c^2}{r^2} + 3\right)\left(\frac{c^2}{r^2} - 1\right) = 0,$$

$$\cos.^2 \theta + \left(\frac{c^2}{r^2} - 1\right) = 0. \quad (3)$$

If $r = 1$ and $c = 8$, (3) becomes—

$$\cos.^6 \theta + 61 \cos.^4 \theta - 4221 \cos.^2 \theta + 63 = 0,$$

whence $\theta = 82°\ 58'\ 55''$.

Substituting this in (1) gives ratio = 1.007784.

Then maximum vel. piston = 60
$+ 1.007784$ times $\frac{2}{7}$ of $60 = 77.276297$
and minimum vel. piston = 60
$- 1.007784$ times $\frac{2}{7}$ of $60 = 42.723703$
If $c = 3$ ft. equation (3) becomes,
$$cos.^8\,\theta + 6\,cos.^4\,\theta - 96\,cos.^2\,\theta + 8 = 0,$$
whence $\theta = 73^\circ\ 10'\ 31''$
and ratio = 1.054639,
giving max. vel. of 60
$+ 1.054639$ times $\frac{2}{7}$ of $60 = 78.079526$ mi. pr. hr.
and min. vel. of 60
$- 1.054639$ times $\frac{2}{7}$ of $60 = 41.920474$ " " "

In both of these cases θ is greater than the angle to the point where the connecting-rod is tangent to the circle; in the first by $0^\circ\ 6'\ 25''$; in the second, $1^\circ\ 38'\ 37''$. The ratio at the point of tangency in the second case is 1.054092.

It is assumed in the foregoing that the piston travels horizontally and on a level with center of drive-wheel.

Since writing the above I have used $r = 1$ and $c = 2$, obtaining $\theta = 67^\circ\ 42'\ 00''$, which is $4^\circ\ 15'\ 54''$ from point of tangency, and ratio = 1.123208. As a check on the figures, and more particularly to guard against an oversight in my equations, I plotted this last to a large scale with great care. This gave the same results, as close as plotting could indicate.

A little investigation will show that the connecting-rod cannot have such length as will make maximum velocity of piston occur when connecting-rod is tangent to the crank-pin circle.

You will notice that No. 4's result agrees with mine for two decimals. He makes $u = 25.33$, while mine, reduced, is 25.33857.

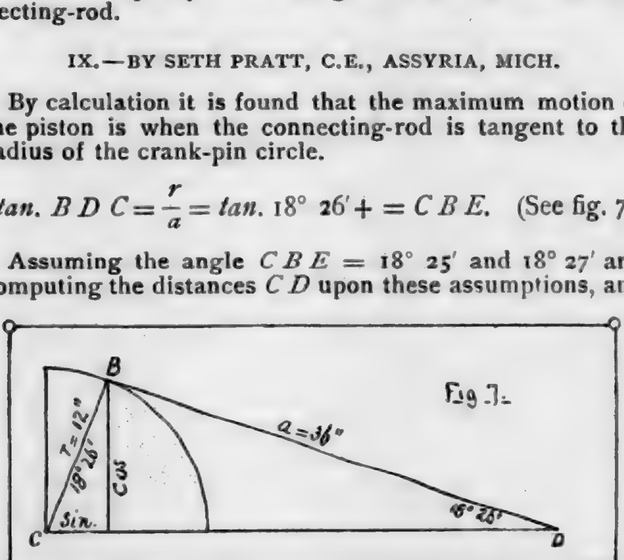
The discrepancy would be greater with a shorter connecting-rod.

IX.—BY SETH PRATT, C.E., ASSYRIA, MICH.

By calculation it is found that the maximum motion of the piston is when the connecting-rod is tangent to the radius of the crank-pin circle.

$$tan.\ B\,D\,C = \frac{r}{a} = tan.\ 18^\circ\ 26' + = C\,B\,E. \quad \text{(See fig. 7.)}$$

Assuming the angle $C\,B\,E = 18^\circ\ 25'$ and $18^\circ\ 27'$ and computing the distances $C\,D$ upon these assumptions, and



taking their *difference*, we get the motion for 2' of that of the wheel.

Now, by the

$$\text{1st.}\begin{cases} r\ sin.\ 18^\circ\ 25' = .3159250 \times 12 = \ \ 3.7911000 = C\,E. \\ r\ cos.\ 18^\circ\ 25' = .9487842 \times 12 = 11.3854104 = B\,E. \end{cases}$$

$$\text{2d.}\begin{cases} r\ sin.\ 18^\circ\ 27' = .3164770 \times 12 = \ \ 3.7977240 = C\,E. \\ r\ cos.\ 18^\circ\ 27' = .9486002 \times 12 = 11.3832024 = B\,E. \end{cases}$$

$$\sqrt{a^2 - B\,E^2} + C\,E = 37.9432951. \quad \text{By the 1st.}$$
$$\sqrt{a^2 - B\,E^2} + C\,E = 37.9506551. \quad \text{By the 2d.}$$

Difference = .00736 = motion for 2',
or $30 \times .00736 = .2208$ in. = motion for 1°.
Since there are four revolutions per second, we have

$$\frac{.2208 \times 4 \times 360^\circ \times 3600''}{12 \times 5280} = 18.06\tfrac{5}{11} \text{ miles per hour.}$$

$60 + 18.06\frac{5}{11} = 78.06\frac{5}{11}$ miles per hour = maximum motion
$60 - 18.06\frac{5}{11} = 41.93\frac{6}{11}$ " " " = minimum motion.

The solutions received have presented the problem in different lights; perhaps our readers can judge whether any of them are entirely correct.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées.*)

I.—INTRODUCTION.

ENGLISH INDIA is certainly the country in which engineers have executed the most numerous and important irrigation works. Dams across the largest rivers, canals several hundred miles in length, carrying to the farmer at all seasons the water necessary to the development of his crops; inundation canals fertilizing the soil during floods; reservoirs of all sizes storing up the water during the rainy season to distribute it in time of drought; works of every kind for watering the high valleys among the hills and the lowlands of the deltas—such form the magnificent system which has been created to protect agriculture against the vicissitudes of climate, and to increase the production of the soil.

This system, which includes some works of great antiquity, extends from the foot-hills of the Himalaya Range to the southern point of India, under widely differing conditions. Among the more important works are:

In the Indus Basin the Bari-Doab Canal, the Sirhind Canal, and other canals fed by the Sutlej River; the overflow canals leading from the Indus itself, etc., etc.

In the Ganges Basin the Western and Eastern Jumna canals; the Upper and Lower Ganges canals; the Agra Canal; the Soane River Canal, and others.

In the valleys of the various rivers flowing into the Gulf of Bengal the Orissa Canal at the mouth of the River Mahanuddy; the Godavery Delta Canal; the Cauvery Canal; the Kistna Delta Canal; the Upper Kistna Canal; the vast reservoirs of Ekruk and Mutha on the upper tributaries of the Kistna; the Chembrambankam Reservoir near Madras and many others.

A complete and detailed study of all these works would be almost an encyclopædia of information for the use of engineers who have to plan irrigation works. No such book exists, and only descriptions of certain works can be found in the papers issued from time to time by the Thomasson College of Engineering at Roorkee, or in an occasional paper read before the Institution of Civil Engineers at London.

In preparing the present paper the writer has been to some extent aided by the Roorkee Treatise on Civil Engineering in India; by Mr. R. B. Buckley's book on the Irrigation Works of India and their Financial Results; and by several official reports; he is also indebted to Sir Colin Scott Moncrieff, now Secretary to the Ministry of Public Works at Cairo, Egypt, who formerly had the direction of important works in India.

The object of the paper is to give a general idea of what irrigation is in India, and to point out some of the principal works of that kind in the country. It can be only a brief summary, a sort of table of contents, incomplete in itself and serving simply to point the way to more profound studies of this great subject.

II.—GENERAL CONSIDERATIONS.

The conditions of climate in India are such that, with a sufficient supply of water, the land can usually be cultivated the entire year and two crops can be gathered. In the spring grain and other products of a temperate climate; in autumn tropical crops such as rice, cotton, maize,* sugar-cane and indigo.

The *régime* of the rivers, and in consequence the method of cultivation, differs widely in different provinces.

In Northern India the great rivers which descend from the Himalaya Region have their lowest waters in winter. The melting of the mountain snows feeds them from March to May; they are generally highest under the action of

* In France corn is generally considered a tropical product, and M. Barois does not seem to know that in America corn is grown successfully much further north than is supposed possible in Europe.

the heavy and almost continuous rains which fall during the *monsoons* from June to September, and after that month they fall rapidly.

In this region the spring crops—called *Rabi*—have special need of irrigation in February and March, when they are coming to maturity and when the rivers are lowest. The autumn crops—the *Kharif*—which are partly watered by the rains, are in hand while the rivers are high, and need water at different times; sugar-cane and indigo chiefly in May and June, and most of the others in September and October, at the time when the farmers begin to plow the ground for the grain crops which grow during the winter.

In years when the rainfall is normal cotton and maize do not need irrigation.

The chief crops are those of spring, the extension of which is limited as much by the supply of water which can be drawn from the rivers as by the extent of land which can be irrigated. These are considered very important, since among them is the wheat which India has been of late years exporting in large quantity, becoming a competitor with Russia and America in the markets of the world.

In Lower Bengal rice is the leading crop, and it receives its irrigation during the season of the floods.

In Central and Southern India the rainy season is short; moreover, the large water-courses, not being fed by mountain snows, have a very restricted flow from April to July; they begin to rise with the monsoon. The most general crop is rice, which grows almost entirely during the wet season, from June to November. Along the rivers the extension of this culture is limited rather by the amount of land which can be irrigated than by the supply of water, which is always sufficient. In the districts away from the large rivers the rain-water flows off too quickly to permit of the cultivation of rice, unless the rainfall is secured and held in reserve in storage reservoirs.

In these southern provinces the winter crops are less important, especially as very little wheat can be grown there.

According to locality, to the abundance or scarcity of rainfall, and to the sources from which the rivers are fed, the utilization of water for agricultural purposes is practised in India in four different ways:

1. By *irrigation canals*, which carry water to the land, either during the whole year or for a part only.

2. By *overflow* or *inundation canals*, which water the autumn crops during the season of floods in the rivers, and which also, before the rivers fall, serve also to irrigate the land prepared for the second or spring crop.

3. By *reservoirs* collecting the waters during the monsoon and storing them up for distribution during the dry season.

4. Lastly, by *wells* dug in the alluvial soil of the valleys and receiving the waters of infiltration. These are largely used to supplement the usual sources of irrigation, when the latter prove insufficient.

The system of inundation canals is especially developed in the Punjâb and throughout the Indus Valley. The reservoir system finds its greatest development in the Presidency of Madras and in Southern India.

The quantity of water needed in the several provinces differs according to the soil, the climate, and the nature of the crops. The duty of the canals depends upon the amount required, and is more difficult to calculate in the northern provinces, owing to the greater variety of crops cultivated there. In the southern provinces, where rice is the dominant crop—almost the only one, in fact—the problem is a very simple one to solve.

A continuous delivery of 9 cub. in. per second on the Ganges Canal, or of 8 cub. in. per second on the Eastern Jumna Canal, is sufficient on the average to irrigate an acre of land. Assuming that for each acre irrigated by a canal there are two acres either not under cultivation or watered by rain or from wells, there would be required an average duty of from 2.67 to 3 cub. in. per second per acre of cultivable land. This proportion differs widely, however, in different localities. For instance, in several districts supplied from the Eastern Jumna Canal the land irrigated each year is from 70 to 80 per cent. of all the cultivable land.

On the Soane Canal an acre under summer culture requires a delivery of 21.5 cub. in. per second; under winter culture this falls to 9.2 cub. in.

In the latest plans for canals in Northern India, it is calculated that from 17 to 30 cub. in. per second are needed for each acre for summer crops, and from 10 to 12.5 cub. in. for winter crops.

The relative proportion of these crops is very variable. Along the Jumna they occupy almost equal areas. In the Northwest Provinces the surface cultivated in summer is, on an average, about 60 per cent. of the land under crops during the winter.

At Tanjore it is estimated that a delivery of 43 cub. in. per second per acre is needed for a rice-field.

In the Presidency of Madras, in calculating the capacity of reservoirs, it is assumed that 3 cub. ft. of water are needed for the continuous irrigation of 1 sq. ft. of land for the entire year. It is, moreover, estimated that a rice-field ought to be covered with water to a depth of 5 in. for 72 days—that is, for 1 acre of rice it is necessary to be able to deliver about 133,000 cub. ft. of water in 72 days. This, with the losses due to evaporation—which may easily rise to about 6¼ ft. in depth in a year in that climate—makes the amount of water which must be stored during the rainy season about 494,000 cub ft. per acre.

All these figures show that it is only by a very careful study of the needs of agriculture in each district that the proper dimensions of irrigation works can be determined.

III.—DAMS.

The English engineers have had to build on many of the great rivers of India, at the head of irrigation canals, large dams intended to retain the water during the season of low water, and to permit the use of the entire flow when needed.

In these works they have generally sought simplicity of construction and easy maintenance and management.

Thus, they have adopted as much as possible fixed dams; they leave only some openings with movable gates to permit the escape of superfluous water, and they provide weirs to prevent the accumulation of deposits about the canal heads. Moreover, where they have found it difficult to reach bed-rock they have usually contented themselves by making for foundations brick-lined wells filled with concrete; these wells are sunk to a greater or less depth in the mud, the sand or the gravel forming the river-bed.

Some dams have no foundations at all, but are simply walls resting on the river-bed and protected against washing out by heavy embankments of stone. This plan, however, can be adopted only when the bottom is not easily permeable, or where the supply of water is so abundant during the season of irrigation that it is not indispensable to prevent the losses which may result from infiltration. In other cases, in Northern India, where there is need of economy in water, it has been found that the foundations formed by lines of wells are not a sufficient obstacle to the escape of water, and the intervals between the wells have been filled by masonry walls.

The conditions of execution of these fixed dams, founded at slight depth upon permeable soils, have required the use of great masses of rock filling, or backing, intended not only to counteract the pressure of the water, but to support the dam under the serious strains caused by the flow over the crest during floods.

The water-courses on which dams have been built in India may be classed under six heads, as below:

1. The river-bed is of rock, or of rock mixed with solid earth or stiff clay; the fall is about 1 in 1,000.

2. The river-bed is a comparatively thin layer of sand resting on clay; the fall is less than 1 in 1,000.

3. The river-bed is of sand and large gravel, mixed with pebbles; the fall is 1 in 2,000.

4. The river-bed is formed, to a great depth, of coarse sand; the fall is from 1 in 5,000 to 1 in 2,500.

5. The river-bed is of fine sand; the fall is from 1 in 20,000 to 1 in 5,000.

6. Lastly, the river-bed is covered with large pebbles and boulders; the fall is from 1 in 333 to 1 in 667.

The back-water caused by these obstructions thrown

across the rivers may reach 3 ft. in height, and if the valleys are not protected, it is necessary to raise the banks or dykes above the dam to prevent overflow. For this reason the general practice has been to reduce the importance of this back-water as much as possible, by adopting for the crown of the work a level from 30 to 40 in. below the maximum desired. The rest of the height is obtained by movable crest-pieces, flush-boards, or horizontal planks held in place by upright bars or frames set in the masonry of the dam.

The openings for waste water or overflow gates are usually of masonry, the gates being placed in them and held by the piers. The gates are generally composed of horizontal boards or iron plates. In many cases wooden gates are used; in others iron gates, lifted by chains and windlasses, and moving on rollers which work on rollers running in grooves in cast-iron plates set in the masonry. When the height is considerable the gate is divided into two parts, which can be worked separately, and are so arranged that the lower edge of the upper gate rests on the top edge of the lower one.

In a few cases, in rivers subject to sudden rise, gates have been used which oscillate around a horizontal axis, and which can be opened and closed by chains.

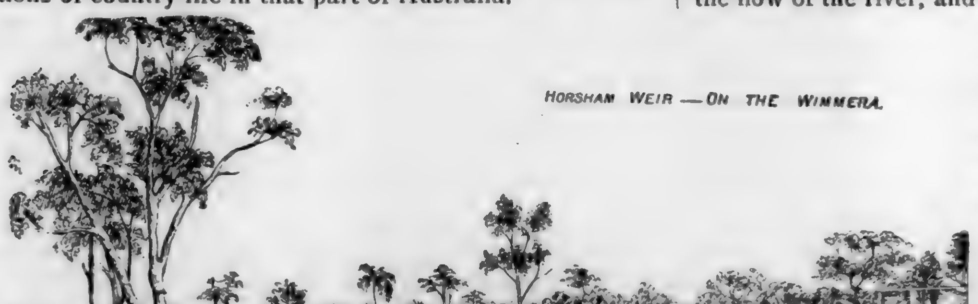
These general remarks may be emphasized and perhaps explained by condensed descriptions of some of the more remarkable dams, which will be given in the next part.

(TO BE CONTINUED.)

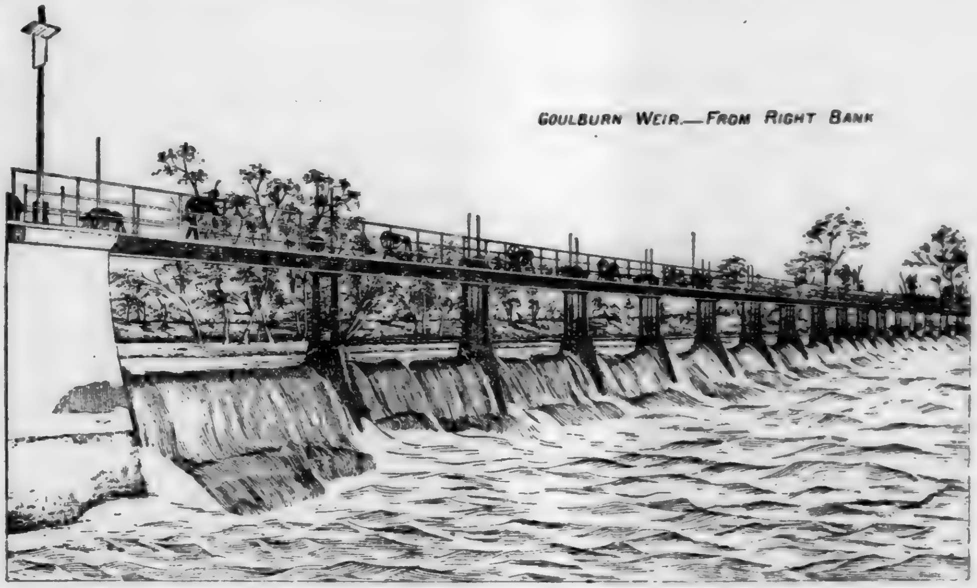
IRRIGATION WORKS IN AUSTRALIA.

(From *Indian Engineering*.)

THE Government of the colony of Victoria is alive to the benefits of irrigation as a means of ameliorating the conditions of country life in that part of Australia.



The National works, constructed with that end, are of a substantial and permanent character. Their supervision, maintenance, and management are charges against the colonial exchequer. Prominent among these is the Goulburn Weir, which forms one of the subjects of the annexed plate. The illustration shows the weir during the occurrence of an extraordinary flood, with a volume of 1,423,000 cub. ft. passing over it per minute.



The site was selected as being the nearest point to the irrigation district at which a rock foundation was obtainable near the surface suitable for carrying a masonry structure. The summer level of the river is raised 45 ft. by the weir, the depth of water from raised water-level to the bed of the river being 50 ft. The weir is of concrete, composed of Portland cement, sand, and broken stone, backed with granite blocks in steps. The lower portion across the channel-way was constructed in four sections within coffer-dams; six tunnels, each of 44 sq. ft., carrying the ordinary flow of the river while the superstructure was in progress. These tunnels are closed at the face by cast-iron gates. The water-way over the weir for the passage of floods is occupied by 21 gates, each 20 ft. wide and 10 ft. high, lowering into recesses or chambers in the body of the structure as may be required to accommodate the flow of the river, and to maintain the water-level as far as possible at 50 ft. above the bed. To lower the gates into chambers was considered the best arrangement with regard to the conditions of the river, and to keep the works as compact as possible. The flood conditions might have been modified by increasing the depth or length of flood water-way, but the provision made was considered adequate, sufficient land being taken to cover the heading. The power for working the flood-gates is obtained from three 30½-in. Leffel turbines. Hand-gearing is also provided over each gate. The turbines can be worked together or separately, and any turbine can be brought into gear with any gate or gates. The head under which the turbines will be worked will vary from 3 ft. to 13 ft., according to the state of the river below the weir, giving from 3 H.P. and 78 revolutions per minute to 27.3 H.P. and 163 revolutions per minute, according to the varying conditions. An electric lighting plant of five arc lamps, driven by a 23-in. Leffel turbine, is provided for night-work.

The off-take channels have head-gates, each 10 ft × 7

ft., pivoted vertically, and worked by worm and worm-wheel gearing. The western off-take has 14 and the eastern 4 of these gates.

Another system for the extension of irrigation in the colony is that through the medium of "irrigation trusts." Very few of these trusts have as yet completed their schemes sufficiently for the expectation of useful results. They are, although generally good and efficient, of a less substantial and permanent character than the National works previously referred to. The Horsham Weir, on the Wimmera, is one of the best examples of a trust work. It is built of timber, and known as a silled structure. We have made it the subject of illustration, because it is favorably mentioned among works of that class. In this connection we may add that the trust to which this weir belongs is said to be progressing steadily in the direction of satisfying the domestic, stock, and irrigation requirements of its constituents.

THE NEW PENNSYLVANIA RAILROAD TERMINAL STATION.

(From the Philadelphia *Record*.)

THE new Broad Street Station of the Pennsylvania Railroad, which is shown in the accompanying cut, will be, the officials of the company declare, the largest and handsomest railroad terminal in the world. Work on the superb structure, which will certainly be one of the noted buildings of the United States, is now progressing rapidly, and within a year or a little more Philadelphians may pride themselves on the possession of this splendid station.

The plans of the new building have been prepared by Furness, Evans & Company, of Philadelphia, and approved by the officials of the company after some minor alterations. The structure is designed to be a mammoth 10-story building of modern Gothic architecture, whose exterior will be finished to correspond with the present station, as its construction will be of granite and brick, with the highly ornamental trimmings and bas-reliefs in terra cotta. Necessary modifications will be introduced in the lines of the new station, so as to obviate any dwarfing of the present building, even though the height of the main tower will be 240 ft., and also to better create a uniform harmonious whole after its completion, when it will stand the most imposing railroad terminal station and shed in the world.

It will extend to Market Street, occupying all of the ground south of the present station between Market Street and the present station, extending west on Market Street over Fifteenth Street, and 60 ft. beyond. This immense building site will afford an extensive increase in the practical operating area and create greater space accommodations for the traveling public. Reducing the territory occupied by the new station and shed to simple figures, it is shown that 4¾ acres of ground are to be under roofing.

The main entrance for outgoing passengers will be at the corner of Broad and Market streets and will be semicircular and imposing in design. Another entrance will be on Filbert Street, west of Broad, and a score or more of great arched entrances will line the front of the building on Broad Street.

All of these entrances will be protected by a glass-covered arcade or awning extending the entire length and covering the pavements on the Broad and Market streets façades, which in inclement weather will form ample shelter for outgoing or incoming passengers.

The plan for the lower floor, which has been designed with the greatest study and care, promises to afford the greatest possible convenience to the public. The entrance hall on the ground floor will extend from Market Street to the baggage-room on Filbert Street, affording commodious accommodations for incoming passengers and avoiding any possibility of a crowd or rush about the ticket windows, the elevators or stairways, and is so designed that the mass of arriving and departing passengers will be entirely separated. The Broad Street side will be virtually thrown open with entrances, and the adjustment of the ticket offices and the exceptional facilities for comfort and rapidity when tickets are to be bought could not be improved upon. The ticket office will be in the middle of the building, situated about where the large exit now is. The main stairway will be immediately back of the range of ticket windows.

The main stairway will consist of two broad flights, one starting from Market Street and the other from the Filbert Street side. These flights will ascend to a common landing, and from this there will be one grand stairway entering in the center of the second or main floor of the station.

On either side of the main flight are two large elevators running between the first floor or entrance hall and the second floor waiting rooms and train entrances. These elevators will also communicate directly with the cabs and carriages on Fifteenth Street.

In view of the fact that the Pennsylvania Railroad Company was the pioneer of the present railroad cab, carriage and hansom service, it is not a surprise to find the space that will be devoted to cabs in the plans of the new structure, and to see the improved conveniences for the public through this medium.

Near the Filbert Street side, on Broad Street, there will be a large *porte-cochere* for carriages bringing passengers to the station, while opening from it there will be a greatly enlarged baggage-room. Thus the arriving passengers having baggage with them to check will be able to purchase their tickets, check their luggage and ascend by the stairways or elevators to the train floor without having to retrace their steps; at the same time they will avoid confusion by coming in contact with the departing traveler. The stand for cabs will be on the Fifteenth Street side, where it will be easy of access by outgoing passengers, and when completed it will occupy about half of the length of the building, making it about twice the present space devoted to this service.

Entering the main floor from the grand staircase there will be presented an interior equipped with general waiting rooms of every description.

The passengers' reception or waiting-room will be extended out to where the line of iron fence is to-day, and the lobby will be 50 ft. wide instead of 30 ft. as it is at present. The grand stairway will open directly in the center of the main waiting-room, 82 ft. wide by 136 ft. in length. Arranged on this floor will be the dining-room, 29 ft. wide by 111 ft. in length. This will extend along the Broad Street front, while adjoining it will be a restaurant 32 ft. wide by 82 ft. in length. Independent of the main waiting-room there will be a women's waiting-room 56 ft. by 82 ft., and a very large room for men. There will be also Pullman and telegraph offices, barber shops, retiring rooms and news-stands. In its interior arrangement, designs and ornamentation it will embody everything of utility, combined with accessories to please the eye.

The main entrance to the office building will be on the Market Street façade, midway between Fifteenth and Broad streets.

Leading from this dignified entrance will be the staircases and three elevators for the exclusive use of the business public and the officers.

There will be another entrance to the office building proper at the corner of Fifteenth and Filbert streets for the use of the army of clerks and employés.

Definite plans for the interior divisions of the upper floors have not as yet been outlined, but it is estimated there will be about 200 various offices so as to accommodate all the officials and clerks who are now in the general offices on Fourth Street. In completing the plans an ample margin has been left in office room for the enormous yearly increase of officials and employés. To this end the new part of the building will be 10 stories high, or eight stories above the main waiting-room on the second floor.

The kitchens will be on the floor over the station dining-rooms and luncheon tables, and will be replete with every modern convenience. All the heats and odors are to be carried off by a system of ventilation. An entrance and elevator at Fifteenth and Filbert streets have been de-

signed for servants, and all necessary supplies for the dining-rooms and kitchens will find their entrance and exit there.

The design of this immense building, as a whole, is also susceptible, should the requirements of the road demand an increased space, of being extended over the present station to a 10-story structure corresponding with the new station as it will appear when erected, thus doubling the capacity of the work now in contemplation and still preserving a harmonious architectural effect.

This great iron and glass portal to Philadelphia will be the largest railroad train-shed in the world, not excepting anything of like construction in this country, or the Midland, the St. Pancras, or the London, Chatham and Dover stations in London. It will cover an area 707 ft. long, 307 ft. wide, and 140 ft. in height from the platform to the ridge of the central ventilator. The main arches will have a clear span of 294 ft. at track level, and a clear height at the center of 104½ ft. above the top of the rail. The entire structure, with its 6,000,000 lbs. of iron, will present the appearance of a gigantic sun-parlor, for its extensive roof is to be largely composed of heavy translucent glass in iron frames. The glass in the roof alone will cover an area of 1¾ acres. The arches span an extreme width which measures 307 ft. without any intervening obstructions or supports, leaving the space clear for 16 tracks and the necessary platforms.

The exteriors of the train hall, both on Market and Filbert streets, have been designed to accord perfectly with the style of architecture used in the station building, thus obviating the usual abrupt incongruity so often seen between station buildings and the train halls, thus making the entire exterior one consistent design.

The height of the roof, the extensive surface of glass used in the covering, will render the shed very light, while excellent ventilation, also attributable to its altitude, will serve to keep the air free of smoke.

One of the most interesting problems connected with the new station will be its construction without interfering with the volume of shipping and travel to and from Broad Street Station. It seems perfectly safe in prophesying that not a detention will occur, however, when the work in New York and Jersey City is taken as a precedent, for there, during the entire construction of the great shed, adjoining buildings and miles of new roadbed, not so much as a single wheel was clogged nor a detention caused in travel.

THE NEW PENNSYLVANIA RAILROAD STATION, BROAD STREET, PHILADELPHIA.

COLUMBIAN EXPOSITION NOTES.

AN application has been made by E. L. Corthell, Chairman of the Executive Committee of Associated Engineering Societies, Chicago, for 1,200 sq. ft. of space in the Transportation Building. The space is to be used by the staff of the Associated Engineering Societies of the United States and Canada for the purpose of aiding engineers from all over the country in examining the engineering exhibit and also the general exhibit of the Exposition. Large photographs of bridges are promised to the Department of Transportation exhibits by the King Bridge Company, of Cleveland, and the Union Bridge Company, of New York, for the display of which wall space has been asked. Joaquin Filippe Nery Delgado, President of the Society of Portuguese Civil Engineers, at Lisbon, applies for 96 sq. ft. of space for books, albums of photographs and albums of drawings and engravings. The State of New York, through Edward Hannan, of Albany, Superintendent of Public Works, wants 5,000 sq. ft. of space in the marine division of transportation exhibits. It is proposed to exhibit the State canal system of New York and photographs, maps, plans, models and drawings of canals, structures, elevators, boats, feeders and towing systems upon navigable waters connected therewith. The Edgemoor Bridge Works of Wilmington, Del., will include in their exhibit metal sections of various bridges, viaducts and other structures, and also large photographs of large and important bridges designed and erected by the firm.

THE special train bearing the 10 big logs destined for the flagpoles for the Washington World's Fair Building at Chicago will be run in three sections of 14 cars each. Each of the logs equals the length of seven flat cars, though they are loaded in such a manner that the weight is

carried by two of the cars. With the exception of the two largest, the logs are placed two together on the cars, but it was impossible to load the two largest in that manner, owing to their enormous weight.

The two end cars of the sections will support the load on a raised block working on a pivot. The other cars will be empty, and the logs will extend over them above the car-floors. This arrangement is necessary owing to the curves in the road. When the train is on a curve, the first and last cars of the section will of course not be in the same straight line, and if the logs were supported by all the cars, it would be impossible to round the curves without breaking either the logs or the cars. To overcome this difficulty the movable blocks on the two end cars are brought into play, and while the empty cars curve around a bend in the track the pivots are also turned, permitting the logs to always retain the same relative position with respect to each other. On sharp curves the middle of the load will be entirely clear of the cars at the center of the section, and will lie parallel to a tangent drawn at the outer edge of the curve. When the curve is passed the pivots again throw the logs back to their original position.—*Spokane Journal.*

THE UNITED STATES NAVY.

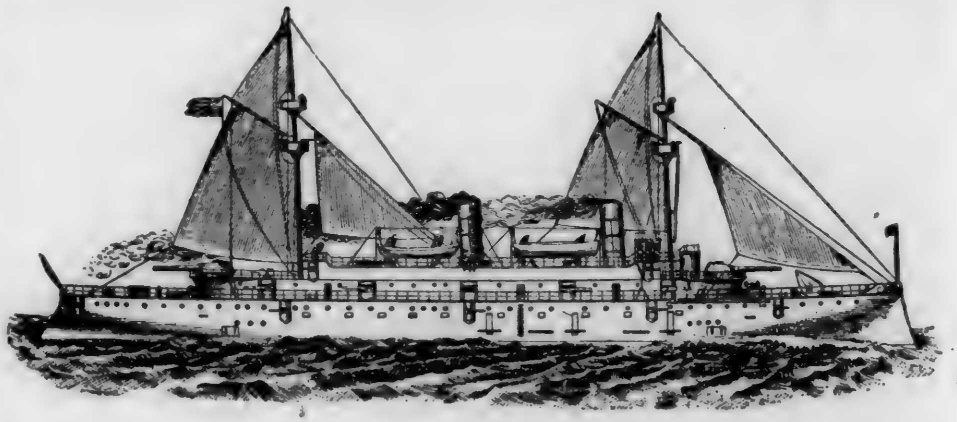
THE progress of the work on the armored cruisers *Maine*, at the New York Navy Yard, and on the *New York*, at the Cramp yards, in Philadelphia, is still delayed by the slow delivery of the armor plates. The dates at which these ships will be ready for service are still uncertain.

The other new ships under construction are advancing well, with the exception of the *Cincinnati*, at the New York Yard. The damage done to the engines by the recent fire in the machine shop will take some time to repair, and the launch of the ship has been postponed for the present. Several of the other new ships, however, will soon be ready for service.

The torpedo-boat No. 2, which is under construction by the Iowa Iron Works at Dubuque, Ia., will soon be ready for launching.

LAUNCH OF THE "OLYMPIA."

The next ship to be launched is cruiser No. 6, which a recent order from the Navy Department has named *Olympia*, after the capital city of Washington. The accompanying sketch is from the plans of this ship published in the report of the Bureau of Construction.



CRUISER "OLYMPIA," UNITED STATES NAVY.

The *Olympia* is a twin-screw, protected cruiser, of the following dimensions: Length on load water-line, 340 ft.; extreme breadth 53 ft.; mean draft, 21 ft. 6 in.; displacement at normal draft, 5,500 tons.

This ship has a protective deck 4¾ in. thick on the slopes and 2 in. on the flat over the machinery space; 3 in. on the slopes and 2 in. on the flat forward and abaft of it.

A belt of water-excluding material 33 in. thick, in coffer-dams extending 4 ft. above and 4 ft. 5 in. below the load water-line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the engine and boiler space. The armored ammunition tubes are 3 in. thick, and the conning-tower 5 in. The hull plating is increased in thickness in the wake of all machine guns.

The main battery will consist of four 8-in. breech-loading rifles in barbette turrets 4 in. thick, and ten 5-in. rapid-fire guns protected by 4-in. segmental shields. The secondary battery will consist of fourteen 6-pounders, six 1-pounders and four Gatling guns. In each of the lower military tops will be mounted a 37-mm. Maxim gun and a 1-pounder Hotchkiss gun. The torpedo outfit will consist of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

There are two vertical, direct-acting triple-expansion engines, one to each screw. The cylinders are 42 in., 59 in. and 92 in. in diameter and 42-in. stroke.

Steam will be furnished by six boilers, two single-ended, each 15 ft. 3 in. in diameter and 10 ft. 11¼ in. long, with four corrugated tubular furnaces; the other four double-ended, 15 ft. 3 in. in diameter and 21 ft. 3 in. long, with light furnaces. They carry 160 lbs. working pressure.

Working at full power and at about 128 revolutions per minute, the engines are expected to develop 13,500 H.P. and to give the ship a speed of 20¼ knots an hour.

The full coal capacity will be 1,300 tons. At maximum speed this supply will give a steaming radius of 2,192 knots. At a speed of 10 knots it will give a cruising endurance of 13,000 knots, or about 54 days' steaming.

A LAKE-BUILT OCEAN TUG.

THE first large tug built at a lake ship-yard for ocean towing purposes was recently launched at the yard of F. W. Wheeler & Company, in West Bay City, Mich. The accompanying engravings are from photographs, and represent the tug upon the ways ready for launching; the launch, and the vessel in the water after launching. It will be noticed that the ways are parallel to the water and that the tug was launched broadside. This method is somewhat risky in appearance, but has been successfully carried out at Bay City and elsewhere with a number of vessels.

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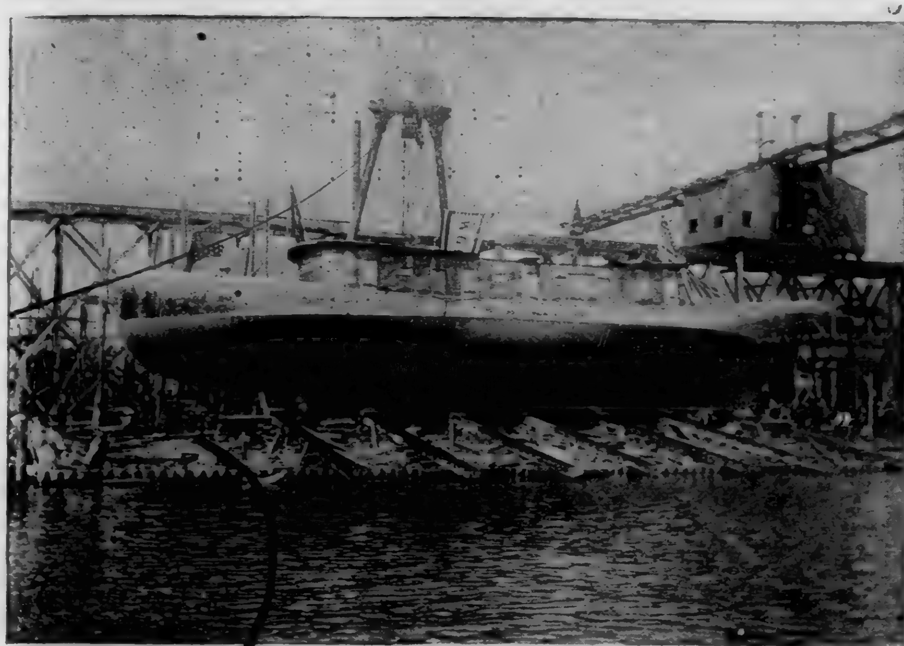

LAUNCH OF THE "W. G. WILMOT," AT WEST BAY CITY, MICH.

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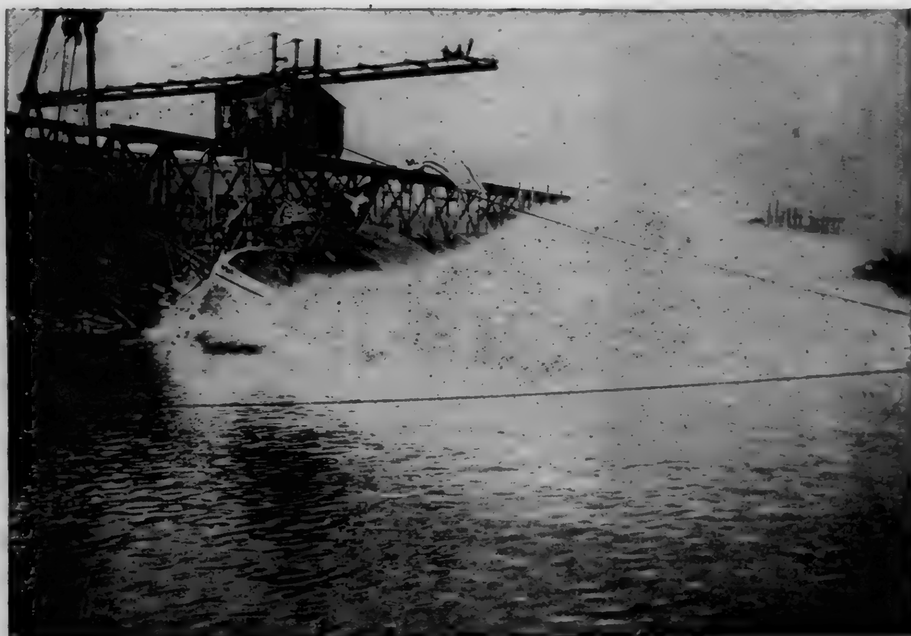

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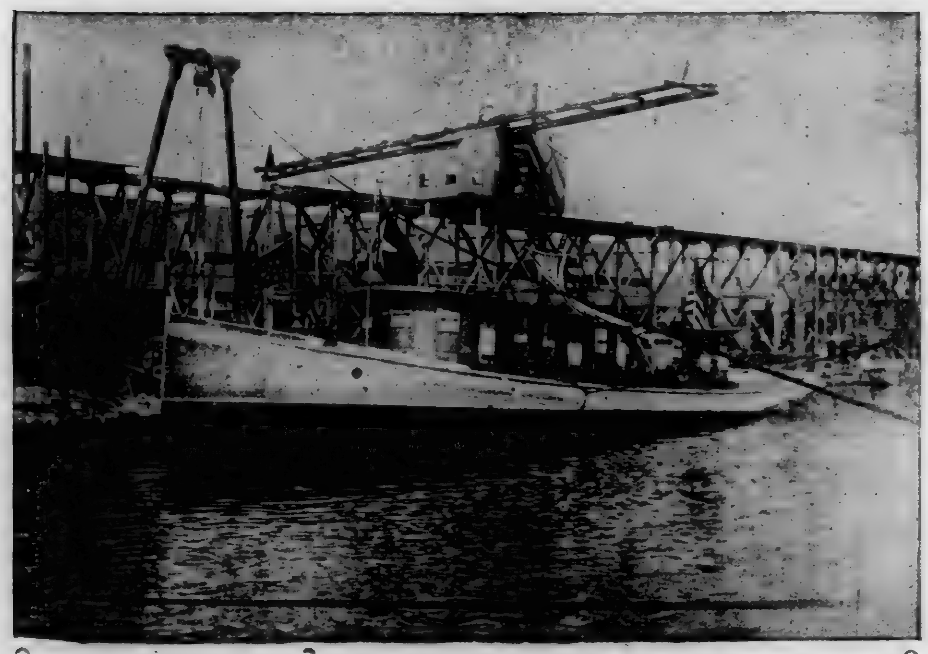


carried by two of the cars. With the exception of the two largest, the logs are placed two together on the cars, but it was impossible to load the two largest in that manner, owing to their enormous weight.

The two end cars of the sections will support the load on a raised block working on a pivot. The other cars will be empty, and the logs will extend over them above the car-floors. This arrangement is necessary owing to the curves in the road. When the train is on a curve, the first and last cars of the section will of course not be in the same straight line, and if the logs were supported by all the cars, it would be impossible to round the curves without breaking either the logs or the cars. To overcome this difficulty the movable blocks on the two end cars are brought into play, and while the empty cars curve around a bend in the track the pivots are also turned, permitting the logs to always retain the same relative position with respect to each other. On sharp curves the middle of the load will be entirely clear of the cars at the center of the section, and will lie parallel to a tangent drawn at the outer edge of the curve. When the curve is passed the pivots again throw the logs back to their original position.—*Spokane Journal.*

THE UNITED STATES NAVY.

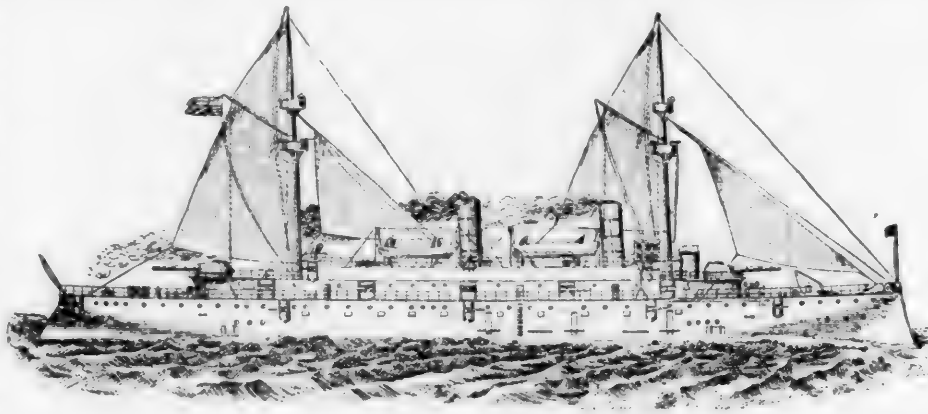
THE progress of the work on the armored cruisers *Maine*, at the New York Navy Yard, and on the *New York*, at the Cramp yards, in Philadelphia, is still delayed by the slow delivery of the armor plates. The dates at which these ships will be ready for service are still uncertain.

The other new ships under construction are advancing well, with the exception of the *Cincinnati*, at the New York Yard. The damage done to the engines by the recent fire in the machine shop will take some time to repair, and the launch of the ship has been postponed for the present. Several of the other new ships, however, will soon be ready for service.

The torpedo-boat No. 2, which is under construction by the Iowa Iron Works at Dubuque, Ia., will soon be ready for launching.

LAUNCH OF THE "OLYMPIA."

The next ship to be launched is cruiser No. 6, which a recent order from the Navy Department has named *Olympia*, after the capital city of Washington. The accompanying sketch is from the plans of this ship published in the report of the Bureau of Construction.



CRUISER "OLYMPIA," UNITED STATES NAVY.

The *Olympia* is a twin-screw, protected cruiser, of the following dimensions: Length on load water-line, 340 ft.; extreme breadth 53 ft.; mean draft, 21 ft. 6 in.; displacement at normal draft, 5,500 tons.

This ship has a protective deck 4¾ in. thick on the slopes and 2 in. on the flat over the machinery space; 3 in. on the slopes and 2 in. on the flat forward and abaft of it.

A belt of water-excluding material 33 in. thick, in cofferdams extending 4 ft. above and 4 ft. 5 in. below the load water-line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the engine and boiler space. The armored ammunition tubes are 3 in. thick, and the conning-tower 5 in. The hull plating is increased in thickness in the wake of all machine guns.

The main battery will consist of four 8-in. breech-loading rifles in barbette turrets 4 in. thick, and ten 5-in. rapid-fire guns protected by 4-in. segmental shields. The secondary battery will consist of fourteen 6-pounders, six 1-pounders and four Gatling guns. In each of the lower military tops will be mounted a 37-mm. Maxim gun and a 1-pounder Hotchkiss gun. The torpedo outfit will consist of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

There are two vertical, direct-acting triple-expansion engines, one to each screw. The cylinders are 42 in., 59 in. and 92 in. in diameter and 42-in. stroke.

Steam will be furnished by six boilers, two single-ended, each 15 ft. 3 in. in diameter and 10 ft. 11½ in. long, with four corrugated tubular furnaces; the other four double-ended, 15 ft. 3 in. in diameter and 21 ft. 3 in. long, with light furnaces. They carry 160 lbs. working pressure.

Working at full power and at about 128 revolutions per minute, the engines are expected to develop 13,500 H.P. and to give the ship a speed of 20¼ knots an hour.

The full coal capacity will be 1,300 tons. At maximum speed this supply will give a steaming radius of 2,192 knots. At a speed of 10 knots it will give a cruising endurance of 13,000 knots, or about 54 days' steaming.

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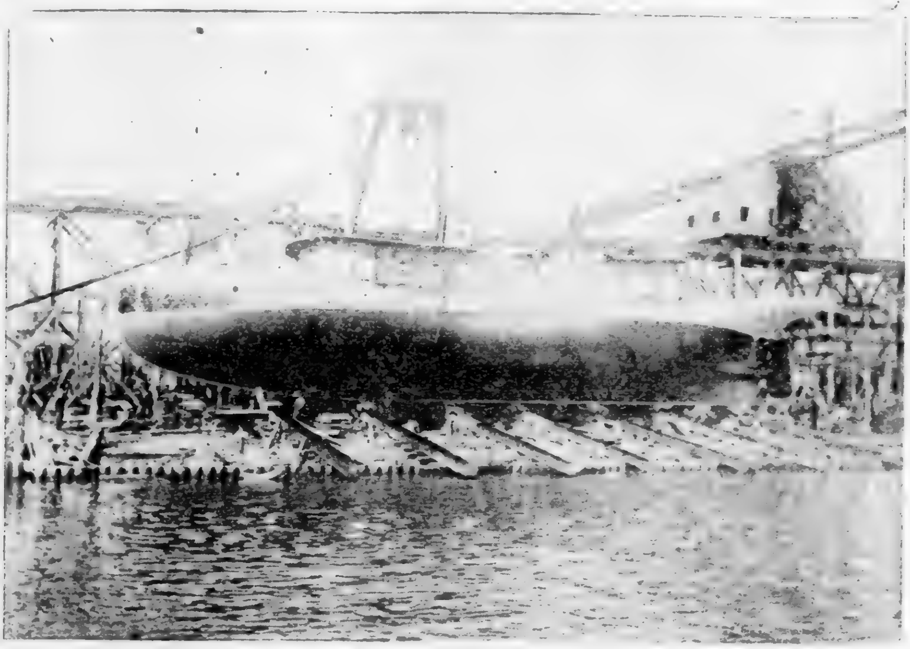

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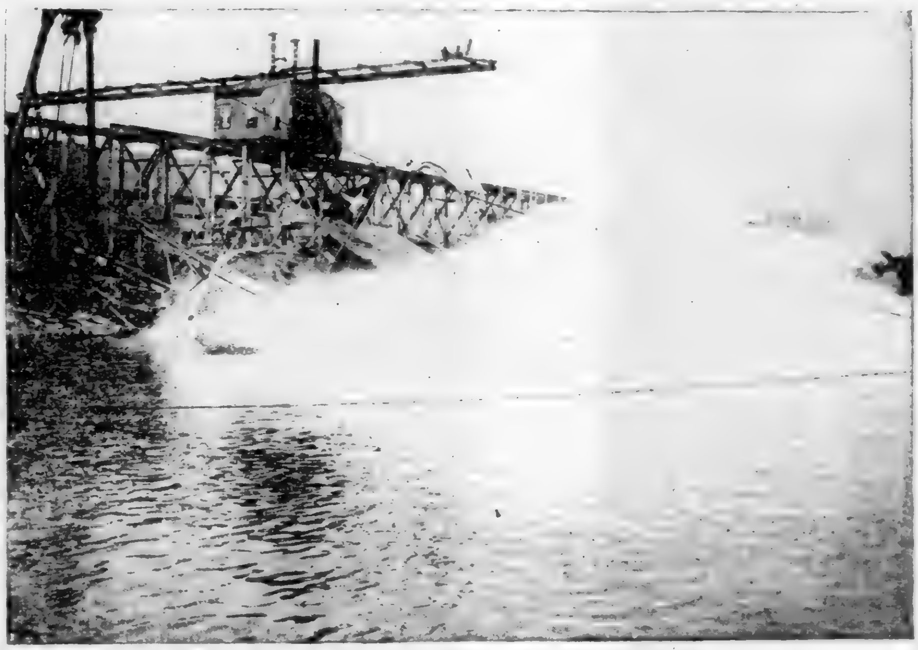

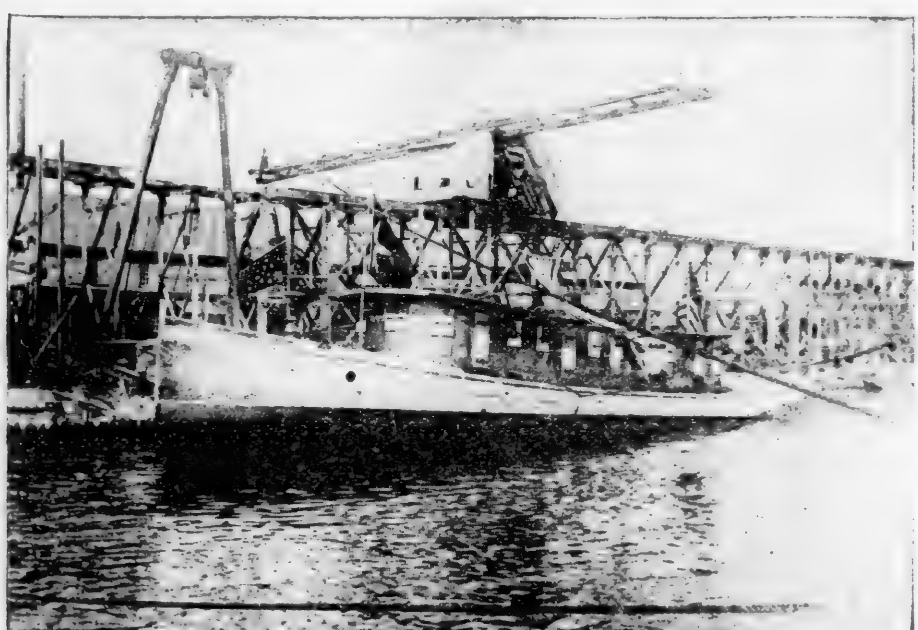

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LOCOMOTIVE RETURNS FOR THE MONTH OF JULY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	50	39,121	73,917	37,989	151,027	3,021	....	....	62.37	78.43	47.85	65.57	....	...	5.10	4.10	0.27	0.50	6.30	2.10	18.37	....	...	....
Alabama & Vicksburg	....	18	18,030	20,945	10,303	49,278	2,738	....	....	51.02	90.90	46.84	68.26	....	....	5.30	5.40	0.30	0.70	6.40	1.80	19.80	....	....	....
Atchison, Topeka & Santa Fé	834	740	....	....	373,868	2,148,162	2,903	....	....	...	....	....	77.10	....	....	4.88	5.94	0.30	0.13	6.57	1.49	19.31	....	...	1.47
Canadian Pacific	596	....	511,845	730,330	252,227	1,715,935	2,879	...	....	....	....	....	59.14	....	...	3.38	10.29	0.38	....	5.27	1.31	20.63	....	....	3.43
Chic., Burlington & Quincy	517	....	....	....	....	1,778,986	3,441	5.33	18.04	....	....	....	75.90	....	....	4.57	5.00	0.20	0.[illegible]	6.52	....	16.49	....	...	1.32
Chicago & Northwestern	869	....	704,292	1,307,945	817,723	2,829,960	3,257	....	....	....	....	....	75.53	....	....	3.30	6.95	0.38	....	6.34	0.85	17.82	....	....	1.82
Cincinnati Southern	....	101	32,812	171,861	82,293	336,966	3,336	....	...	49.50	110.49	31.28	78.13	....	....	4.20	4.50	0.28	0.80	6.50	1.60	17.88	....	....	....
Cleve., Cinn., Chic. & St. L.	....	....	....	....	....	....	...	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn	23	22	5,532	30,721	....	36,253	1,648	....	....	....	....	....	80.64	....	....	4.18	4.30	0.40	....	....	1.20	9.88	...	....	....
Delaware, Lackawanna & W. Main L.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Morris & Essex Division	157	....	172,358	270,042	12,265	424,665	2,705	....	....	....	....	....	54.23	....	....	3.69	8.49	0.38	...	6.21	...	18.77	....	....	...
Hannibal & St. Joseph	78	68	77,471	144,785	36,882	259,138	3,811	4.95	17.63	...	....	....	75.90	13.96	5.46	6.46	5.39	0.24	0.21	6.93	....	19.23	....	....	1.28
Kan. City, F. S. & Mem	....	146	101,161	194,796	112,153	408,110	2,795	....	....	....	....	....	51.77	....	...	3.64	4.43	0.29	0.46	7.33	....	16.15	....	....	1.65
Kan. City, Mem. & Birm	41	40	36,208	51,822	19,841	107,871	2,697	....	....	....	....	....	58.22	....	....	2.71	3.50	0.27	0.39	6.99	....	13.86	....	....	1.15
Kan. City, St. Jo. & Council Bluffs	....	44	59,791	47,258	43,406	150,449	3,419	4.93	21.65	....	....	....	59.10	11.57	4.28	5.61	4.99	0.12	0.09	5.49	....	16.18	....	....	1.79
Lake Shore & Mich. Southern	588	561	440,391	685,139	584,405	1,709,935	3,048	....	....	56.27	80.03	31.03	57.90	....	....	3.19	4.49	0.16	....	6.88	0.22	14.94	....	....	1.40
Louisville & Nashville	....	*339	441,697	837,090	407,635	1,686,422	3,772	5.14	16.80	60.77	104.80	58.33	78.13	11.87	6.05	4.06	6.59	0.26	1.37	6.10	0.59	18.97	3.09	1.39	1.70
Manhattan Elevated	....	278	749,143	....	56,965	806,108	2,900	....	...	....	....	....	38.09	....	....	2.20	7.60	0.30	....	8.70	....	18.80	....	....	3.96
Mexican Central†	146	116	....	....	....	388,544	3,346	....	...	....	....	....	60.70	....	....	4.74	13.82	0.47	0.20	5.53	0.84	25.60	....	....	5.32
Mil., L. S. & Western	112	108	82,685	159,778	120,470	362,933	3,453	....	....	....	....	....	66.18	....	....	2.77	9.24	0.26	....	6.12	0.92	19.31	....	....	2.80
Minn., St. P. & Sault Ste. Marie	....	....	69,035	132,258	42,947	244,240	....	4.66	20.03	...	....	....	60.34	....	....	3.29	9.92	0.19	....	6.33	....	19.73	....	1.53	3.26
Missouri Pacific	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....
N. O. & Northeastern	...	35	30,250	57,206	27,254	114,710	3,277	....	....	65.57	106.38	36.90	80.00	....	....	4.90	6.70	0.30	0.40	6.50	1.60	20.50	....	....	....
N. Y., Lake Erie & Western	618	....	479,771	952,154	297,158	1,729,083	2,798	4.90	22.70	84.30	120.10	63.10	...	17.10	5.30	4.61	6.45	0.40	1.65	7.16	1.17	21.44	...	1.55	1.28
N. Y., Pennsylvania & Ohio	259	...	148,185	429,387	139,364	16,936	2,768	6.00	18.20	67.00	117.30	66.50	....	11.20	6.50	4.29	5.62	0.31	1.75	6.85	1.03	19.87	....	1.64	1.15
Norfolk & Western, Gen. Eastern Div.‡	....	143	96,390	239,493	63,863	397,746	2,782	4.80	19.50	....	...	....	75.24	....	....	6.80	2.90	0.80	....	....	....	10.50	....	...	....
Durham Division‡	....	5	7,182	13,680	3,000	23,862	4,772	5.00	3.00	....	....	....	43.01	....	....	1.90	4.30	0.50	....	....	....	6.70	....	....	....
Radford Division‡	....	50	16,368	111,312	10,537	138,217	2,764	5.40	18.20	....	....	....	117.65	...	....	9.50	4.80	0.70	....	....	....	15.00	....	....	....
Pulaski Division‡	....	28	26,011	43,568	10,175	79,754	2,848	5.10	13.30	....	....	....	92.16	....	....	3.70	13.10	0.60	....	...	....	17.40	...	....	....
Clinch Valley Division‡	....	36	21,435	51,178	16,685	89,298	2,480	3.90	10.70	....	....	....	106.38	....	....	6.20	4.30	0.90	....	....	....	11.40	....	....	....
Winston-Salem Division‡	....	9	15,114	12,586	3,437	31,137	3,460	2.40	8.60	....	....	....	69.68	....	....	5.60	2.50	0.90	....	....	....	9.00	....	....	...
Old Colony	....	229	374,075	135,489	129,508	639,072	2,791	....	....	....	....	....	54.49	....	....	3.31	10.22	0.61	....	6.55	0.77	21.46	....	....	3.75
Philadelphia & Reading	....	....	491,435	713,704	528,443	1,733,582	....	....	....	....	....	....	74.93	....	....	4.13	4.19	0.33	....	5.74	0.41	14.80	...	....	....
South. Pacific, Pacific System	710	....	....	....	....	1,802,710	2,539	....	....	....	...	....	68.47	....	...	4.75	18.30	0.40	2.07	7.36	1.11	33.99	....	...	5.42
Union Pacific	996	....	724,745	1,306,504	467,172	2,498,421	2,508	5.72	16.04	....	....	....	93.94	13.51	7.90	6.96	9.18	0.43	0.77	8.02	1.13	26.49	4.23	2.02	1.95
Vicksburg, S. & P.	....	14	11,614	10,868	9,856	32,338	2,310	....	....	49.26	80.37	25.25	53.19	...	....	2.40	5.70	0.24	1.00	6.60	2.50	18.84	....	....	....
Wabash	403	351	409,313	654,478	271,374	1,335,165	3,804	5.12	17.43	64.33	94.52	55.56	77.34	12.56	5.42	3.08	4.39	0.29	....	6.18	0.87	14.81	2.46	0.99	1.13
Wisconsin Central	151	130	138,353	217,176	82,826	438,355	3,372	....	....	...	....	....	72.07	....	....	2.94	9.07	0.28	....	7.16	....	19.45	....	....	2.47

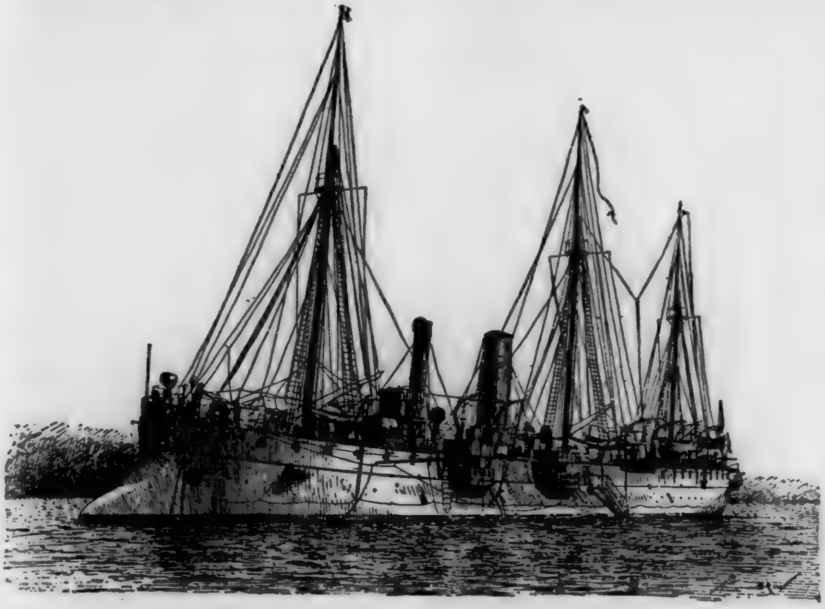
NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 19.6 units of work per $1 of expense; 180.1 units of work per ton of coal; 11.10 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

THE accompanying illustration, from *Le Yacht*, shows the third-class cruiser *Lalande*, of the French Navy. This vessel is a twin-screw steel cruiser, built to attain a speed of 19 knots



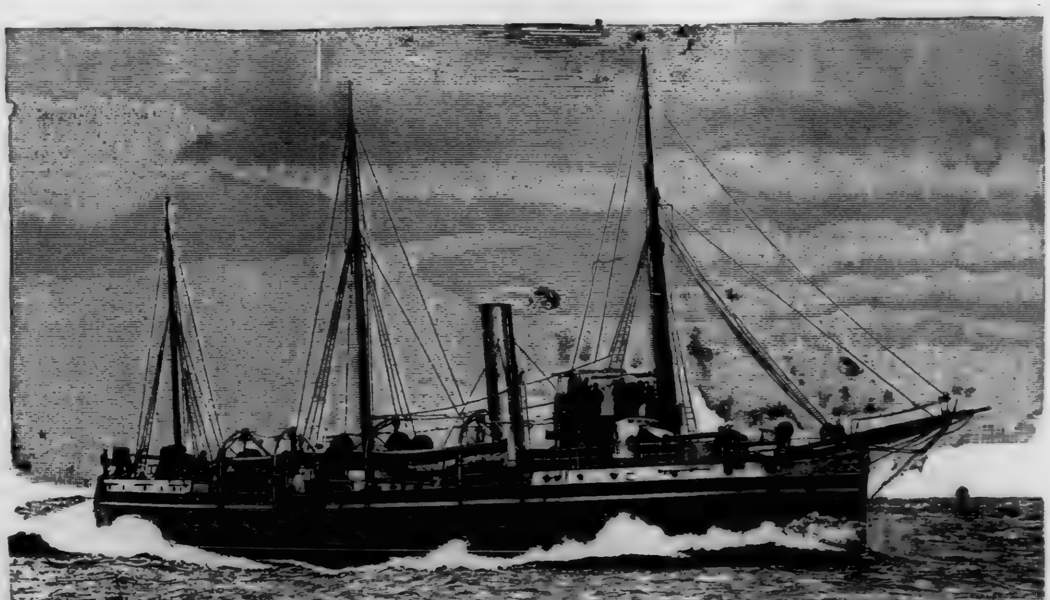
THIRD-CLASS CRUISER "LALANDE," FRENCH NAVY.

with forced draft. She has the high freeboard, narrow deck and long ram bow which characterize the French cruisers of her class.

The *Lalande* is 311.6 ft. long, 29.5 ft. beam, 17 ft. mean draft and 1,877 tons displacement. Her engines work up to 6,000 H.P. She carries four 5.5-in. breech-loading rifles; three rapid-fire guns; four revolving cannon, and five torpedo tubes. She has no armor except a protective deck covering the machinery and magazines.

THE sea-going torpedo-boat *Dragon*, recently completed in the Normand yards at Havre, for the French Navy, on her trial trip maintained for five hours an average speed of 18.2 knots an hour. With forced draft and engines working to their highest point she kept up for one hour the remarkable speed of 25.03 knots. The consumption of coal at 18.2 knots was 1,534 lbs. per hour; it reached 3,967 lbs. per hour at the highest speed, with forced draft.

THE firm of Sir W. G. Armstrong & Company, at Elswick, England, has nearly completed two cruisers for the Brazilian Navy. The first, the *Republica*, is 206 ft. long, 35 ft. beam, 12.8 ft. mean draft and 1,300 tons displacement. She has twin screws and triple-expansion engines which can work up to 3,300 H.P. with forced draft, giving a speed of 17 knots. She carries six 4.7-in. cannon, four 6-pdr. rapid-fire guns, six machine guns and four torpedo-tubes.



CRUISER "TRIDENTES," FOR THE BRAZILIAN NAVY.

The second ship, which has been named *Tridentes*, is a twin-screw cruiser 173 ft. long, 30 ft. beam, 10.7 ft. mean draft and 800 tons displacement. Her armament will consist of four 4.7-in. guns, three 6-pdr. rapid-fire guns, four machine guns and two torpedo-tubes. Her engines are of the triple-expansion type, and can work up to 1,200 H.P. with forced draft. The contract speed of this ship is 14½ knots at full power.

THE Elswick yards have also nearly completed two ships for the Argentine Navy. The first is the torpedo cruiser *Aurora*, which is 204 ft. long, 20 ft. beam, 13.6 ft. draft, and 500 tons displacement. Her engines can work up to 2,300 H.P., and her maximum speed is 18 knots.

The second is a cruiser named the 9 *Julio*, and is to be a very fast boat. Her engines are designed to develop 14,500 H.P., and she is expected to make 22½ knots an hour in smooth water. This ship is 350 ft. long, 44 ft. beam, 26 ft. mean draft and 2,560 tons displacement.

THE HIGHEST INITIAL VELOCITY.

IN the latest number of *Mittheilungen aus dem Gebiete des Seewesens* an account is given of some extraordinary results obtained in experimental firing with a Canet rapid-fire gun of 57 mm. (2.24 in.) caliber. The remarkable point about these tests is that in them the highest initial velocity on record was obtained. These tests were made in May and June last, but the results, we believe, have not been made public until the present time.

If all the conditions of the trial are considered, it will be seen that the extraordinary result obtained was not due to the weight or form of the projectile. The shot used with the 57-mm. Canet gun weighed 2.7 and 3.0 kg., which does not differ materially from those used with other rapid-fire guns of the same caliber. Thus the projectile of the 57-mm. Grüson gun weighs 2.72 kg.; of the Hotchkiss, 2.725 kg.; of the Krupp, 2.75 kg., and of the Maxim, 2.72 kg. The reason for the very high initial velocity is found in the great length of the bore of the Canet gun, and in the use of a very slow-burning powder. While the 57-mm. Grüson, Krupp, Maxim and Hotchkiss rapid-fire guns have bores of the lengths of 20, 30, 42 and 44 calibers respectively, the Canet has a length of bore of 80 calibers.

The results obtained are given in the following table, in which the original metrical figures have been reduced to feet and pounds. The powders used were varieties of the French naval powders:

No. of Shot.	Weight of Projectile.	Kind of Powder.	Weight of Charge.	Initial Velocity.	Gas Pressure.
	Lbs.		Lbs.	Feet.	Lbs. per sq. in.
1	5.95	BN, 1 Los.	1.763	2,125	14,023
2	5.95	" "	2.424	2,594	24,244
3	5.95	" "	2.645	2,801	26,944
4	5.95	" "	3.086	3,109	37 082
5	5.95	" "	3.196	3,218	43,667
6	5.97	BN, 2 Los.	2.920	2,818	27,646
7	6.61	" "	2.920	2,739	28,500
8	6.61	" "	3.086	2,821	29,162
9	5.95	BNG	2.204	2,558	19,808
10	5.95	"	2.645	2,972	27,881
11	5.95	"	2.865	3,142	31,229
12	5.93	"	2.975	3,188	31,627
13	5.95	"	2.975	3,273	35,002
14	6.61	"	2.865	3,123	34,548
15	5.95	"	3.086	3,283	35,392
16	6.61	"	3.086	3,296	42,606
17	5.95	"	3.086	3,323	36,270
18	6.61	"	3.086	3,214	37,[illegible]55
19	6.61	"	3,086	3,263	37,688

The average of shots Nos. 15 and 17 showed, with a charge of 3.086 lbs. of powder and a projectile of 5.95 lbs., an initial velocity of 3,303 ft. per second. The average of shots 16, 18 and 19 gives with a charge of 3.086 lbs. and a 6.61-lbs. projectile, an initial velocity of 3,257 ft.

According to previous experience, the point to be feared was that so long a gun might be so far acted upon by the shot as to become slightly deflected; but it does not appear that this result followed the trials referred to.

The flight or path of the shot was so even that the gunner was able to aim at and strike a target 19.7 ft. high, placed 5,400 ft. distant, even without a special sight. Such a target would cover any ordinary ship or coast fortification.

Recent Patents.

DERLON'S UNIVERSAL-JOINTED BRACE.

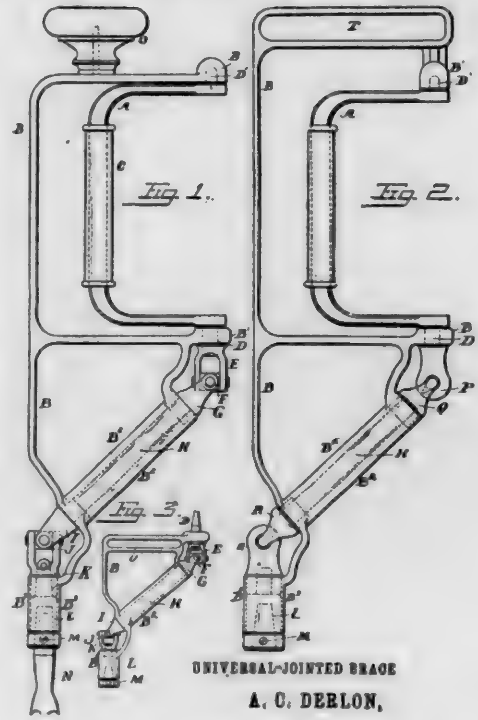
THE accompanying illustrations show a convenient little device for which patent No. 481,526 was recently issued to A. C. Derlon, of Paris, France. It is a brace for boring holes in corners and other places where an ordinary brace cannot be turned; figs. 1, 2 and 3 show different modifications. It is, as the drawings very plainly show, simply a frame carrying in the upper part a brace handle, and below a shank and bit, the two being connected by a shaft having a universal joint at each end, and enclosed in a long bearing. It is so plainly shown, that further description is hardly needed.

JOHNSTONE'S BRICK ARCH FOR FIRE-BOXES.

The annexed drawing shows a form of brick arch for locomotive fire-boxes covered by patent No. 481,232, recently issued to Mr. F. W. Johnstone, Locomotive Superintendent of the Mexican Central Railway. Its object is to admit the application of the arch to an ordinary fire-box, without the use of attachments to the side-sheets. Fig. 1 is a section, fig. 2 a plan, and fig. 3 a detail of the fastening.

The invention consists in the combination, with a locomotive fire-box, of a transverse girder or support fixed below the mud-ring or bottom bar, a brick arch supported on said girder, and an auxiliary ash-pan located below the fire-box and between the girder and the flue-sheet.

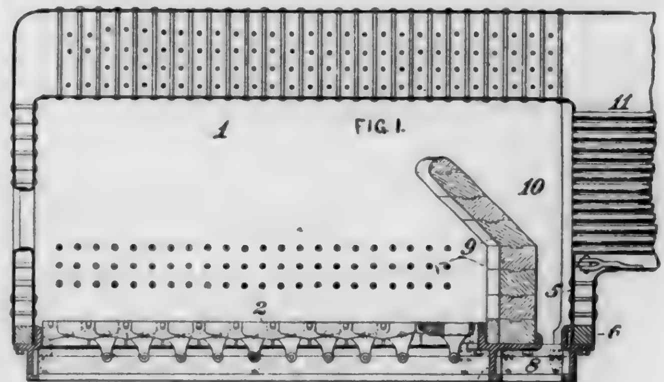
The device is shown in the drawings as applied to a Belpaire fire-box, but it can be used with any of the ordinary types of fire-box. The fire-box is provided at bottom with a suitable grate 2, which extends for the major portion of its length and with an ordinary ash-pan 3 below the grate. A girder or support 4, which is preferably of cast iron, extends across the bottom of the fire-box in front of the ash-pan 3—that is to say, at or near its end which is adjacent to the flue-sheet 5—said girder being secured at its ends either to the side members of the mud-ring or bottom bar 6 of the fire-box, as shown in fig. 3, or to the engine-frames when the fire-box is so located relatively thereto as to make such attachment convenient or desirable—for example, entirely above the frames, as is frequently the case in recent and present practice. The girder 4 forms the rear wall of a supplemental ash-pan 7, which extends below the forward portion of the fire-box to or near the



UNIVERSAL-JOINTED BRACE

A. C. DERLON,

plane of the flue-sheet 5, and is provided at its sides with tight doors or dampers 8. An arch or bridge-wall 9, formed of a series of fire-brick sections, and having, preferably, a rearwardly inclined upper portion, rests upon and is supported



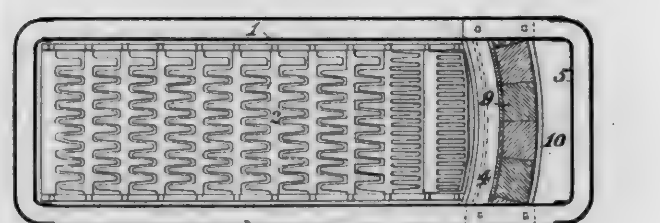
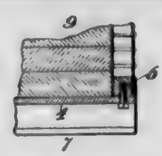


FIG. 2.

FIG 3



BRICK ARCH FOR LOCOMOTIVE FIRE BOXES.

F. W. JOHNSTONE.

wholly by the girder 4, which may be, as shown, provided with lateral flanges on its upper surface to abut against and hold in position the lower sections of the arch 9. The space 10 between the arch and the flue-sheet is open at bottom to the supplemental ash-pan 7, and serves the purpose of a combustion-chamber in which the combustion of the gaseous products of the ignited fuel on the grate is perfected before passing into and through the tubes 11.

It will be seen that the construction described obviates the necessity of perforating the fire-box sheets for the attachment of the supporting devices ordinarily heretofore employed, and that the brick arch may be readily put in place and removed or repaired, as required. The supplemental ash-pan 7 being practically air-tight, such cinders as may be carried over the top of the arch by the action of the exhaust fall into a space in

Fig. 1

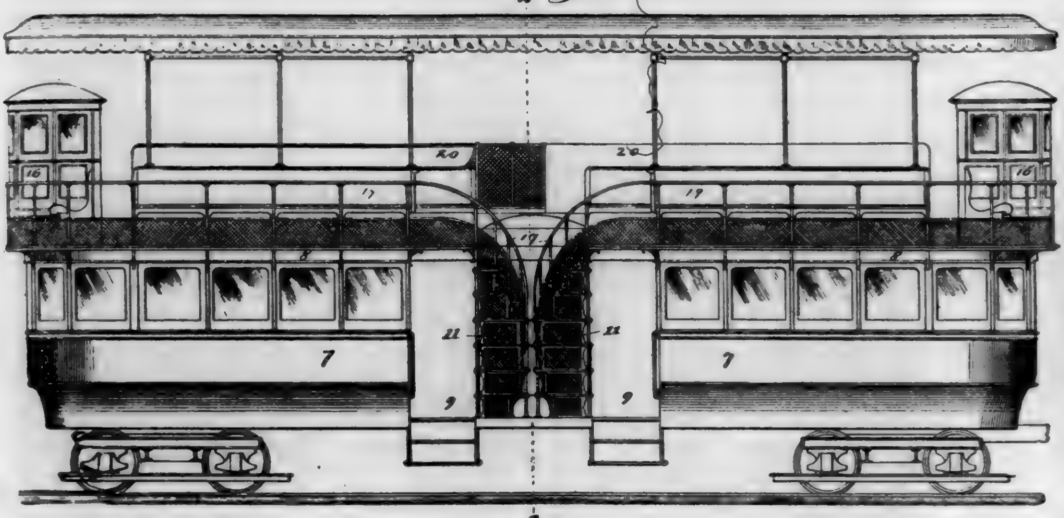


Fig. 2.

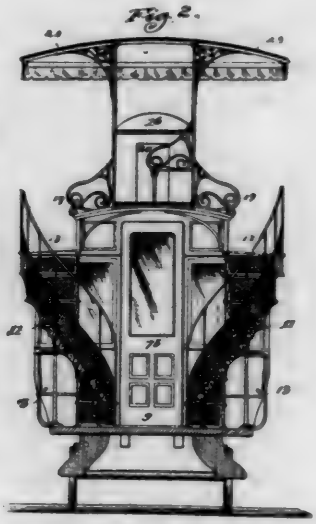
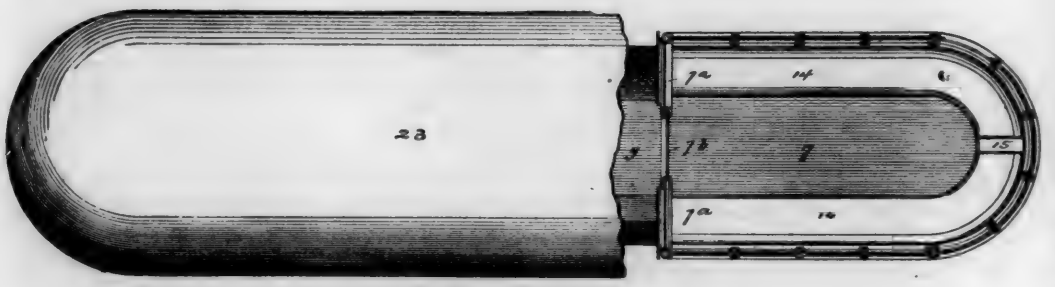


Fig. 3.



PULLMAN'S IMPROVED STREET CAR.

which they are undisturbed by any upward draft, and remain quiescent in the supplemental ash-pan, from which they may be removed at proper intervals through the openings controlled by the side doors or dampers 8.

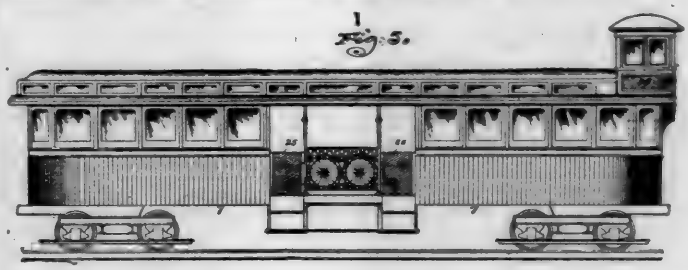
PULLMAN'S STREET CAR.

In figs. 1, 2 and 3, given herewith, there is shown an improved form of street car, for which Patent No. 471,761 has been issued to Charles Pullman, of Chicago, Ill. Fig. 1 is a side view of a car; fig. 2, a cross-section; fig. 3, a plan, with part of the roof broken away to show the arrangement of seats in the body of the car. The plan and arrangement are very well shown in the drawings. The object is to do away with some objectionable features in the usual construction of street railroad cars by dispensing with the end platforms and dividing the car transversely below the deck-line into two compartments, each occupying one end of the car and communicating with each other by a central vestibule provided with side entrances, through which the passengers enter and leave the car near its middle instead of at its ends, as in the previous construction. This vestibule is covered partially or wholly, according as the car is double or single decked, and its floor is formed by the car floor. Its sides may be partically closed by central panels, and it is best to provide sliding doors on both sides of the car and on each side of the panels and steps leading from each of the doors. The vestibule may be separated from the end compartments by transverse partitions having sliding doors. The car is thus practically divided into several compartments—a central vestibule partially or wholly enclosed and provided usually with seats and adapted for smoking-room, a seating compartment at each end of the car opening off the vestibule and preferably separable therefrom, and a roof compartment with seats so arranged as to utilize all the available space without interfering with the comfort of the passengers or subjecting them to inconveniences. The conductor's position is in the vestibule, and enables him to oversee all the passengers and to rapidly collect the fares, while a special cab is provided for the driver at an elevation and apart from the passengers, so that he is in the best position to control his car.

A special feature of this invention relates to the provision of stairways leading to the roof seats. These stairways in the preferred construction are two in number, each located substantially in the plane of the sides of the car, and each stairway being located centrally of the length of the vestibule and having common steps at the bottom and branching toward their tops into two flights, which flights land the passengers facing toward the ends of the car and at four points upon the roof, so that four passengers may enter or leave the stairways at the same time. There are thus provided two separated or divided central entrances upon each side of the car, and the car may be thus rapidly filled or unloaded without confusion or delay.

Where the upper deck seats are not required, they may be omitted, and an ordinary roof used, with only the driver's cab

Fig. 5.



projecting above it, as shown on a smale scale in fig. 5. This plan of car is especially adapted for electric and cable lines.

Some Compound Locomotive Patents.

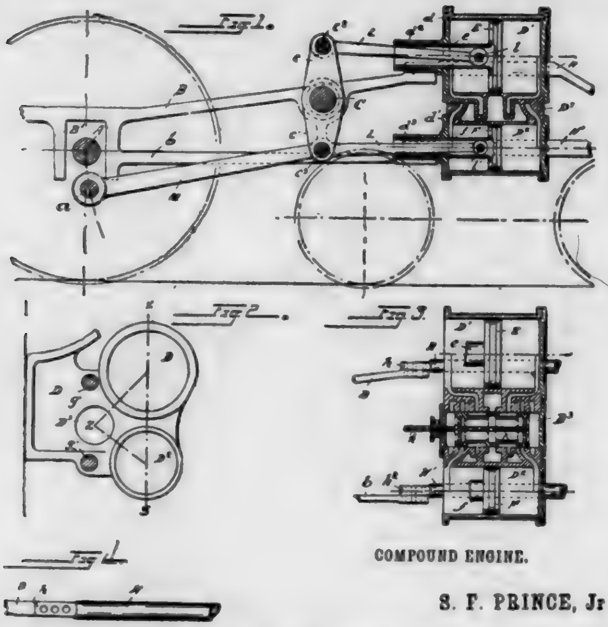
We give below two new patents recently issued for improvements in compound locomotives, or for new devices intended to increase the efficiency of that type of engine.

PRINCE'S COMPOUND LOCOMOTIVE.

This invention, for which patent No. 480,781 has been issued to Samuel F. Prince, Jr., Superintendent of Motive Power of the Long Island Railroad, is shown in figs. 1, 2, 3 and 4. Fig. 1 is a side elevation showing the cylinders in section on

line $x x$, fig. 2. Fig. 2 is an end view of the cylinder-casting. Fig. 3 is a sectional view taken on line $x z y$, fig. 2. Fig. 4 is a separate view of the cylindrical frame-section.

The high-pressure cylinder D^2 and low-pressure cylinder D' are represented as cast in one piece D, in which is also formed



COMPOUND ENGINE.

S. F. PRINCE, Jr

an intermediate cylindrical steam-chest D^3. In this chest is located a valve K, by means of which the steam distribution is effected, so as to cause the pistons to move in opposite directions.

The rear cylinder-heads d and d' are formed with long stuffing boxes or guides d^2 and d^3, within which move the projecting hollow trunks e and f of the pistons E and F for the high and low pressure cylinders, respectively. Within these hollow trunks at l and l' are pivoted the front ends of piston-rods L and L', the rear ends of which are connected directly at c^2 and c^3 to the opposite arms c and c' of a rocking arm C, which is journaled in the frame B of the engine. A connecting-rod M, which is represented as pivoted at c^3 to the same pin which connects the piston-rod L' to the rocking arm, is connected to the crank-pin a, through the medium of which the main axle A is rotated. The upper and lower members B b of the frame, which extend forward from the pedestal B', stop somewhat short of the cylinder-casting D, which is secured thereto by means of separate sections H and H' of the frame, the front ends of which are not shown. These sections are of cylindrical form for a whole or a portion of the part which engages the cylinder-casting and are adapted at the ends h h^2 to be secured to the frame B b, either by squaring the ends, as shown, to a cross-section, which is within the cross-section of the cylindrical portion, so that said sections of frame may be entered or withdrawn from cylindrical openings g and g', formed in the cylinder-casting D, or by a socket or other suitable connection, the cylindrical sections being firmly fitted in the openings g and g' in the cylinder-casting, so as to effectually prevent any movement on the frame-sections other than longitudinally without bolting the casting thereto, such longitudinal movement being prevented by end keys, as usual. By employing this means of attaching the cylinder to the frame, the inventor claims that he has secured economy in construction and avoided the use of bolts passing through the cylinder-casting and frame.

REAGAN'S COMPOUND LOCOMOTIVE.

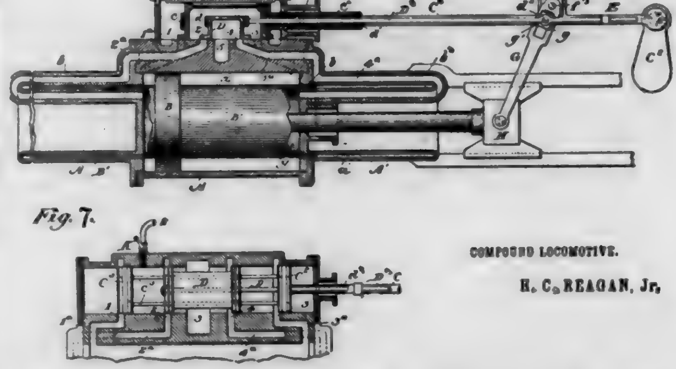
This somewhat peculiar construction is covered by patent No. 481,149, issued to H. C. Reagan, Jr., of Philadelphia. It is shown in fig. 5, a section of the cylinder; fig. 6, a detail; and fig. 7, a section of the steam-chest and valve of a different form from that in fig. 5.

Each cylinder A is provided with a piston B, which has on each side a cylindrical shell B', somewhat longer than the cylinder and less in diameter. These shells slide steam-tight in annular wells a, cored or otherwise formed in annular projections A', cast integral with or attached to the cylinder-heads. A packing-ring b is sprung into a groove near the outer end of each shell. The interior of the cylinder is thus divided into two concentric chambers x and y. The outer or annular chamber x is used as a high-pressure cylinder and the inner chamber y as a low-pressure cylinder, conducting the exhaust-steam from x into y, as hereinafter explained. To prevent too great transmission of heat from the chamber x to chamber y, the shells may be cast hollow and filled with asbestos b^2, in which case the shells are made separate from the piston and bolted thereto.

The valve-seat has two sets of admission-ports 1 3 2 4 and a single exhaust-port 5. The ports 1 3 lie farther from the exhaust-port and communicate by passages 1^a 3^a with the high-pressure chamber x. The ports 2 4 lie nearer the exhaust-port and communicate with the low-pressure chamber y by means of the passages 2^a 4^a, cored out in the valve-seat and in ribs b', which run out around the extensions B' and into the cylinder-heads. By conducting the high-pressure exhaust from passage 1^a into the opposite passage 4^a the desired compounding effect is reached. This may be done by any suitable valve or valves. The main valve C is arranged to open and close, the high-pressure ports 1 3 being given the proper lead and lap. It is actuated by a yoke c, to which is secured a sleeve c', which passes out through a stuffing-box at the back end of the steam-chest. An offset c^2 affords a point of attachment for the main valve-rod C', which is joined to the rocker-arm C^2 and is driven by the ordinary link and eccentrics. The low-pressure ports 2 4 and the exhaust-port 5 are never uncovered by this large main valve C. An auxiliary valve D is inclosed within the main valve C and opens and closes the ports 2 4, placing them alternately in connection with the interior of the main valve and with the exhaust-port 5. The valve D is actuated by a yoke d, attached to a rod D', which passes through a sleeve d', fastened to the valve C and lying concentrically within the sleeve c'. A packing-ring d^2 on the rod D' makes a tight joint between the rod and sleeve. The valves are free to move vertically in their yokes to allow for wear of the valve-seat, and the sleeve d' is smaller than the sleeve c', leaving an annular space to permit the valve C to settle downward as it wears on its seat.

By the operation of the main valve C the live steam is admitted alternately to the two ends of the chamber x, and the exhaust therefrom flows into the interior of the main valve.

The piston-valves shown in fig. 7 need no especial description, since their construction and operation are well understood. The pistons C^3 C^3 are joined by the rods c^3 and constitute the main valve C. The auxiliary valve D is hollow to



COMPOUND LOCOMOTIVE.

H. C. REAGAN, Jr.

permit the rod c^3 to pass through it and the steam to get from port 3 to port 2 and from port 1 to port 4, as explained above. A starting-valve K is placed in a pipe k, which leads from the boiler, so that live steam can be admitted to both sides of the high-pressure piston area and to one side of the low-pressure area simultaneously.

Manufactures.

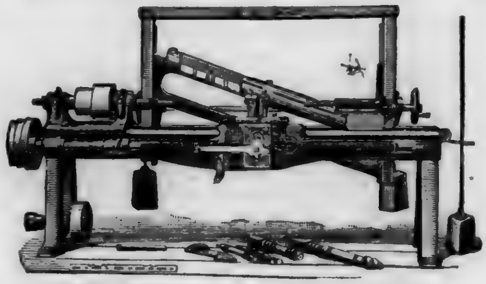
A New Automatic Gauge Lathe.

The cut given herewith shows one instance of the advance made in wood-working tools intended to save time and labor. Heretofore large turning has been done on the ordinary wood lathe by hand, a slow method, and the tool shown has been devised to meet a demand for a lathe which will turn out such work automatically and with precision. This lathe is called by the makers No. 5, and will turn stock up to 6 in. in diameter and 42 in. long, a size heretofore considered impossible for an automatic lathe.

The bed is made in one solid piece, of extra width, planed perfectly true, with V's for the sliding rest to run back and

forth on, and a center bar on which is attached the form or pattern for roughing out the stock ready for the back knife to make the finishing cut. The top of the bed is also planed true, bringing the centers always exactly in line with each other.

The head-stock is furnished with journal-boxes of extra length lined with genuine babbitt metal, perfectly rigid to receive the large spindle, and on this spindle is a cone pulley with two speeds and an extra speed to drive the feed, connect-



NEW AUTOMATIC GAUGE LATHE.

ing a short countershaft below, which is part of the machine. Suitable provision is made for taking the thrust of the spindle.

The tail-stock is made on an improved plan and is provided with gears and screws so as to apply the power as near the center as it is possible to get, brnging same exactly in line with the driving center. This tail center revolves in a gun-metal taper sleeve box. Lost motion can be taken up from time to time so as to enable the operator to run a tight center. Provision is made to withstand the thrust of this center. Both the head and tail-stock are planed on the bottom so as to bring them exactly in line with each other.

The sliding carriage is made to move back and forth along the ways by a screw, operated by a cone pulley and from the feed-shaft below. Provision is made for opening and closing the nut automatically for moving the carriage back and forth. It is also fitted up with two adjustable arms, one for the roughing stock to fit the thimble-plate, and the others for roughing out the molded part of the stock, ready for the back knives to make their cut.

The back-knife attachment is connected to the bed, supported at the top and held perfectly rigid. The bar which carries the back knives is made to slide up and down in planed ways, countered by weights and controlled by the sliding rest. By this arrangement, the back knives are made to act on the stock close to the thimble-plate or support, thereby allowing the back knives to cut perfectly smooth and free. The back knives are attached to the bar and adjust on the frame and can be regulated to suit the different diameters to be turned.

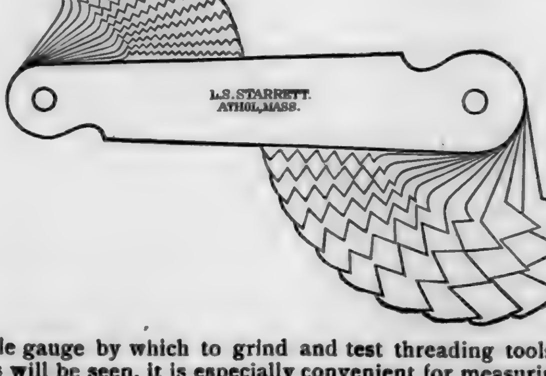
There are three changes of feed furnished with the machine and two speeds to the cone to suit the different diameters of stock to be turned.

Further information can be obtained from the Egan Company, No. 194–214 West Front Street, Cincinnati, O., the builders and originators of this machine.

A New Screw-pitch Gauge.

THE accompanying illustration, which shows the gauge full size, represents a very handy gauge for measuring the pitches of screws. The teeth are sharp and clean cut, and it is a reli-

A NEW SCREW PITCH GAUGE.



able gauge by which to grind and test threading tools, at 60°. As will be seen, it is especially convenient for measuring inside threads.

The gauge shown is made to measure 24 different pitches: 4, 4½, 5, 5½, 6, 7, 8, 9, 10, 11, 11½, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, and 30. It is called No. 4 by the maker, Mr. L. S. Starrett, of Athol, Mass. Its convenience will be recognized by all machinists and foremen.

General Notes.

THE Akron Tool Company, Akron, O., recently made a large shipment of the McNeil balanced charging barrows for railroad work, is now making a large lot of special pattern for the United States Government. These barrows were recently adopted, after careful tests, by one of the oldest blast furnace companies in Pittsburgh.

THE Schenectady Locomotive Works recently completed for the Chicago & Alton Railroad six 10-wheel passenger engines with 19 × 24-in. cylinders and 70-in. drivers. The boilers are built for 170 lbs. working pressure.

THE Pittsburgh Locomotive Works are building 15 Mogul freight engines, with 19 × 26-in. cylinders, for the Duluth, Mesaba & Northern Railroad. These works recently completed for the Pittsburgh & Western a two-cylinder compound engine of the 10-wheel type, for freight service. This engine has cylinders 19 and 29 × 25 in. and 52-in. driving-wheels.

THE Baldwin Locomotive Works, in Philadelphia, recently built for the Atlantic Coast Line five locomotives for passenger service, having 68-in. driving-wheels. Three of them are simple engines and the other two are four-cylinder compound locomotives of the Vauclain type.

THE Youngstown Bridge Company, Youngstown, O., has taken a contract for a bridge over the Brazos River, near Sealey, Tex., on the new extension of the Missouri, Kansas & Texas Railroad.

THE Pacific Bridge Company, of San Francisco, has contract for the steel draw spans over the Nootsak River near Ferndale, Wash.

THE Baldwin Locomotive Works, in Philadelphia, are building a 10-wheel passenger engine of the Vauclain compound type for the Delaware, Lackawanna & Western Railroad. The cylinders are 13½ and 23 × 24 in. This will be the first compound locomotive on that road.

THE Brooks Locomotive Works, in Dunkirk, N. Y., are at work on an additional order for 25 freight engines for the Great Northern Railroad. They have recently completed a four-cylinder compound locomotive, with the cylinders placed in tandem, for that road. This engine will be tested on the Lake Shore road before it goes to the Great Northern.

THE Atlantic Coast Line is building 300 freight cars at its shops in Wilmington, N. C. Of these 225 will be ventilating cars for market traffic, and will be equipped with air brakes and M. C. B. standard couplers.

THE Jackson & Sharp Car Company, Wilmington, Del., are building six passenger cars for the Valley Railroad, of Ohio, and several passenger and baggage cars for the Atlantic Coast Line.

THE Madison Car Company, Madison, Ill., is building 500 box cars for the Wabash Railroad.

RECENT orders received by the Michigan-Peninsular Car Company, Detroit, Mich., include 600 box cars for the Lake Shore & Michigan Southern, and 1,000 box and coal cars for the Toledo & Ohio Central Railroad.

Steam-Heating Valve for Locomotives.

THE Consolidated Car-Heating Company has gotten up a special throttle valve to place on a locomotive for the purpose of controlling the connection by which steam is supplied to the train. This valve is made somewhat after the style of the valve furnished by the Westinghouse Air Brake Company for the purpose of controlling the admission of steam to the air brake pump. It, however, is made for 1-in. pipe instead of ¾ in. It has a connection for the dry-pipe, and is made very heavy and substantial.

This valve is also so designed that it can be placed in a horizontal position at the side of the boiler should there be lack of space on top of the boiler itself. It is so arranged that the dry-pipe connection may be made by the means of a bushing and entirely independent of the valve. This construction permits the throttle-valve to be placed directly on the boiler, or at any other convenient position in the steam pipe.

This valve is made of the best material, and is prepared to carry the highest steam pressures.

The Consolidated Company has also put upon the market a dust guard for the Sewall coupler, which is effective and simple. It is attached to the support chain of the Sewall coupler, and when the coupler is not in use it holds the coupler up and closes the end.

Svenson's Drawing Table.

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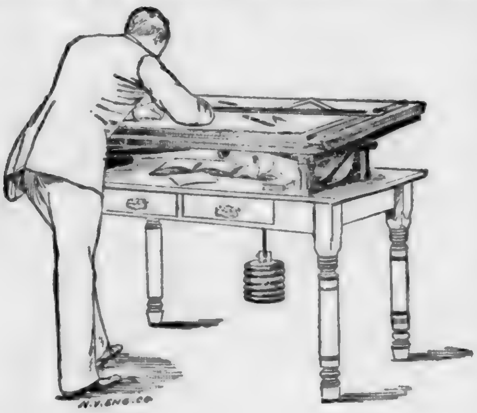

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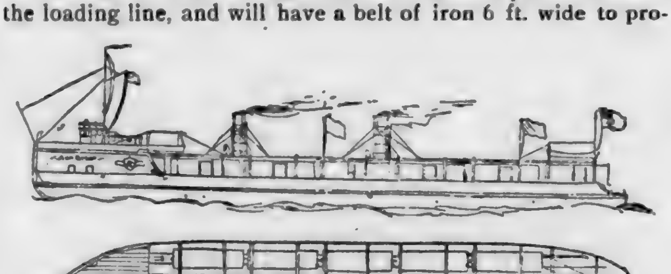

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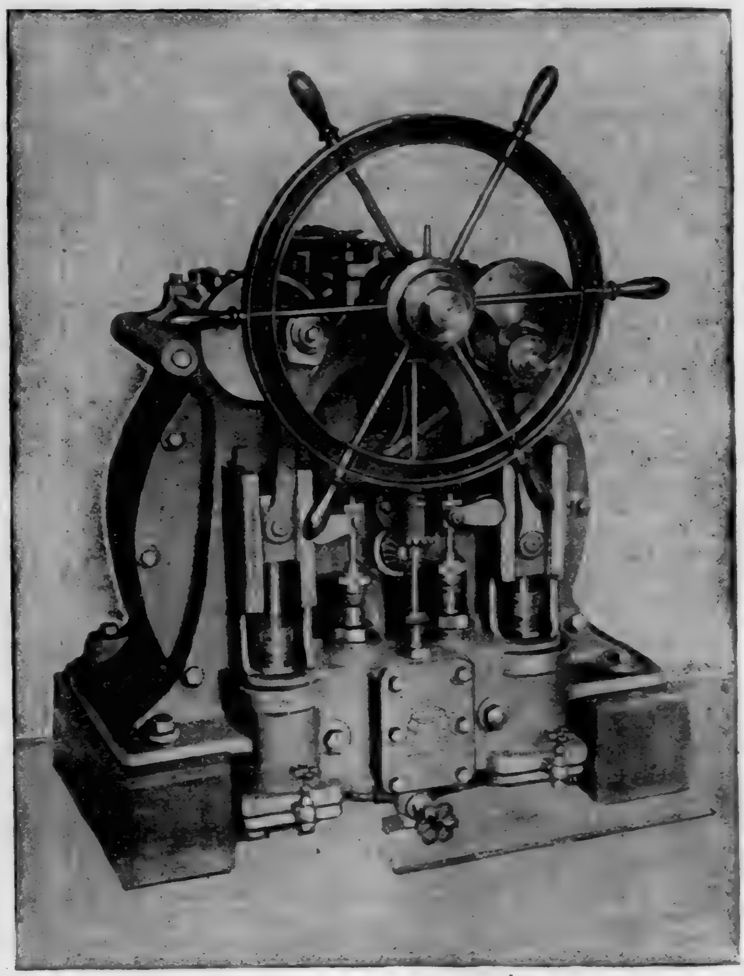

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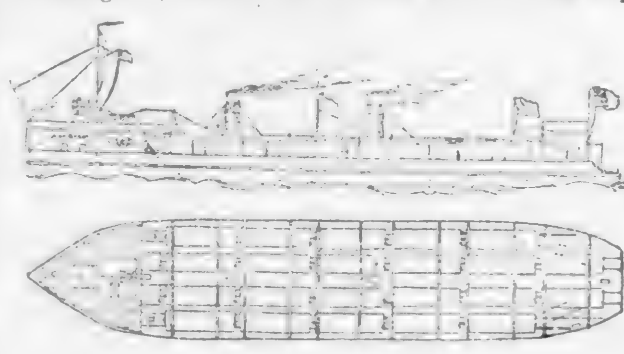

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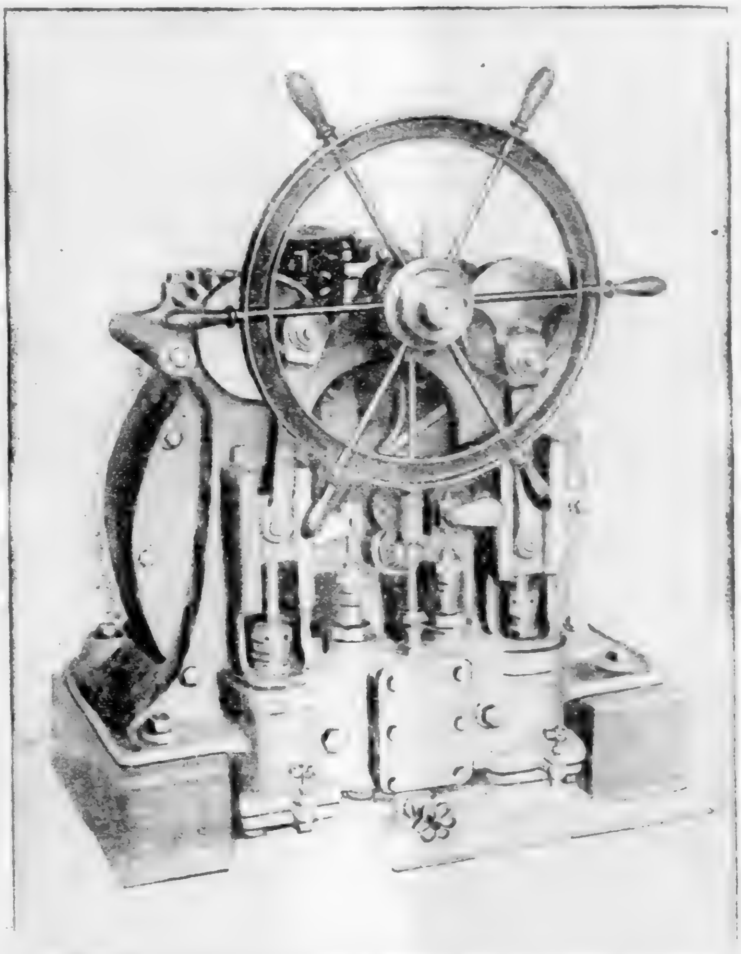

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B. F. CHADBOURNE, of Biddeford, has been appointed Railroad Commissioner of Maine. Mr. Chadbourne is an engineer, and has had much experience in railroad building in Maine, in Pennsylvania and in the South.

J. D. HAWKS has resigned his office as Chief Engineer of the Michigan Central Railroad, and has accepted the position of Manager of the Citizens' Street Railroad of Detroit. Mr. Hawks has had many years' experience as a railroad engineer, and has a high reputation.

C. M. BUCHHOLZ, Chief Engineer of the New York, Lake Erie & Western Railroad, has resigned that position, and has been chosen President of the Quaker City Elevated Railroad of Philadelphia. He will have charge of the building of that company's lines, the first of which is to run along Market Street. PROFESSOR LEWIS M. HAUPT is Consulting Engineer of the company.

JOHN KIRBY has retired from his position as General Master Car Builder of the Lake Shore & Michigan Southern Railroad, but will still remain in the service of the company, having supervision of the construction of new cars. Mr. Kirby has been for 34 years in charge of the Car Department, first of the Michigan Southern & Northern Indiana, and since the consolidation, of the Lake Shore & Michigan Southern. His successor as General Master Car Builder is A. M. WAITT, who has for some time been Mr. Kirby's assistant.

OBITUARIES.

JOHN M. SULLIVAN, who died in Richmond, Va., October 8, was for a number of years Master Mechanic of the Wilmington & Weldon Railroad, but for some years past has been General Foreman of the Richmond Locomotive & Machine Works.

CAPTAIN EDWARD MAGUIRE, of the United States Corps of Engineers, died in Philadelphia, Pa., October 10. Captain Maguire was born in Tennessee 46 years ago, and graduated from West Point in 1867. He held several prominent positions in the Engineer Corps, and several years ago published a book on "The Attack and Defense of Coast Fortifications." He was the engineer officer under General Terry in the campaign against the Sioux Indians succeeding that of the battle of Little Big Horn, in which General Custer was killed.

PROCEEDINGS OF SOCIETIES.

American Association of Railroad Superintendents.—The 21st meeting was held in New York, Monday, October 10. An amendment to the by-laws was adopted providing for a standard committee on Railroad Signals.

The Executive Committee presented a report on its proceedings since the last meeting which included action on the railroad exhibit at Chicago, and on several other matters. This Committee also announced that it had issued invitations in response to which delegates were presented from the Master Car-Builders', the Master Mechanics', the Roadmasters', and the Train Despatchers' Association. These delegates were presented and were cordially welcomed to the meeting.

A communication relating to the capacity of freight cars was referred to the Committee on Transportation, and a number of other communications were also referred to the proper committees, including one on the matter of a record of railroad employés.

The Secretary's report showed a total of 183 active, 10 associate, and 1 honorary member, representing 130 railroad lines. Applications for membership have been received from 55 persons representing 28 additional roads.

The Secretary presented a paper on Maintenance of Way, having special relation to the use of tie-plates on roads where the traffic is heavy. The Committee on Machinery presented a report on Compound Locomotives. This report was only a preliminary one, and suggested a number of points upon which further information was desired in order to make up a full report.

The Committee on Signals, through its Chairman, presented a long and interesting report, which did not receive full consideration owing to lack of time. In addition to this report, papers were presented of the Block System and on the Methods of Draw-bridge Protection.

The Committee on Transportation presented a report covering a brief catechism for railroad employés, and especially for trainmen. It was resolved that this catechism be presented to the Committee on Train Rules of the American Railroad Association, with the request that it be added to the present standard book of Train Rules.

Mr. Willard A. Smith, Chief of the Department of Transportation of the Columbian Exposition, made an interesting statement as to the character of the promised exhibit, which he said has exceeded all expectations.

The following officers were elected for the ensuing year: President, H. Stanley Goodwin; Vice-Presidents, G. W. Beach and C. H. Platt; Secretary, C. A. Hammond; Treasurer, R. W. Sully; Executive Committee, W. G. Watson and C. D. Hammond. It was decided to hold the spring meeting next year in Chicago, the time to be fixed by the Executive Committee.

In the evening the annual dinner of the Association was held, at which a number of members and invited guests were present.

American Society of Civil Engineers.—At the regular meeting on September 21 a discussion on Professor Merriman's paper on Roofing Slates, by Mr. C. B. Brush, was read. A paper on Tests of Power Required to Drive Electric Street Cars, by L. B. Bonnett, was read and briefly discussed, the importance of determining the loss of power in transmission being especially insisted upon. A third paper by Mr. Alfred F. Sears on Motive Power for Street Railroads was read and discussed, the advantages of steam motors, cables, and electricity being presented.

AT the regular meeting, October 5, a brief report of the delegates appointed to attend the International Congress on Internal Navigation at Paris was presented.

A paper on Combination Bridges on the Pacific Coast, by A. D. Ottewell, was read. He referred to the extensive use of combination bridges of wood and iron, which was chiefly due to the excellent quality of timber which could be obtained in that region. Several examples were sited, including the cantilever bridge across the Umpqua River in Oregon, which has a clear span of 290 ft.

Notes on Foundation Experiences, by Alfred P. Boller, was the second paper read. Both papers were briefly discussed.

THE following candidates were elected by the Board of Direction October 4.

Associates: Ludlow V. Clarke, Jr., Philadelphia, Pa.; Wilbur Chapman Fisk, New York City; Clifford Richardson, Washington, D. C.; Frederick Newton Willson, Princeton, N. J.

Juniors: Warren Rue Kinsey, Newark, N. J.; Morris Knowles, Montclair, N. J.; Reuben Miller, Jr., Pittsburgh, Pa.; Henry Lewis Oestreich, Jr., New York City; José Antonio Ruiloba y Dowling, Havana, Cuba; Francis Nicoll Sanders, Albany, N. Y.; Samuel Richards Thomas, Hokendanqua, Pa.; Elton David Walker, Chicago, Ill.; George Shreve Wilkins, Princeton, N. J.

The following candidates were elected by letter ballot:

Members: Charles Lee Crandall, Ithaca, N. Y.; William Lafayette Darling, Helena, Mont.; Augustus Jay Du Bois, New Haven, Conn.; Ignacio Garfias, Mexico, Mexico; Wallace Clyde Johnson, Niagara Falls, N. Y.; Harvey Linton, Altoona, Pa.; Lewis Abel Nichols, La Salle, Ill.; Joseph Hill Paddock, Connellsville, Pa.; Charles Herbert Wright, Wilmington, Del.

Associate Members: Robert Campbell Gemmel, Pendleton, Ore.; Francis Asbury Lyte, Kane, Pa.; Sidney Austin Parsons, Everett, Wash.; George Warner Sherwood, Riverside, Cal.; Jonas Waldo Smith, Montclair, N. J.; William de Hertburne Washington, New York City.

Engineers' Club of Philadelphia.—At the regular meeting of October 1, the tellers reported the election of the following gentlemen to active membership: Pierre Giron, William L. Austin, J. S. Robeson, George H. Paine, Daniel W. Pedrick, Charles S. Schwarz, W. G. Coughlin, Paul L. Wolfel, William C. H. Slagle, George F. D. Trask and Silas G. Comfort.

The resignation of Mr. Edwin S. Cramp was presented and accepted.

Mr. John C. Trautwine, Jr., was appointed to serve as the Club's representative to aid the Committee of the American Society of Civil Engineers, by the suggestion of suitable persons to furnish papers for the meeting of the World's Congress Auxiliary of the Chicago Exposition.

Mr. Strickland L. Kneass read a paper on the History and Development of the Injector, giving a detailed description of the Giffard injector, as originally constructed, and the improvements devised to overcome the objections urged against it. The self-regulating principle, as embodied in the movable com-

bining tube and the double jet injector, was explained, and interesting statements were given regarding the extended use of the injector as a boiler feeder at the present day. Mr. Kneass' paper was illustrated by a large collection of handsome working models, showing the development of the injector from the earliest invention to the best types now in use, and also by blackboard sketches.

Mr. Carl G. Barth gave an interesting blackboard discussion of the Distribution of Pressure in Bearings, maintaining that the center of pressure in an ordinary step bearing should be taken at one-half the radius, instead of two-thirds, as is usual. After considering a number of theoretical questions relating to cylindrical bearings, Mr. Barth gave some practical suggestions regarding their application to machine construction, and concluded by showing the advantage of placing and proportioning all bearings according to the principles demonstrated.

His results were discussed at some length by Messrs. Christie, Wilfred Lewis and others.

Boston Society of Civil Engineers.—The first meeting of the season was held in Boston, September 21. Joseph N. Drew, of Malden, Mass., was chosen a member. The President announced the death of Mr. James B. Francis, the oldest member of the Society, and a committee was appointed to prepare an appropriate memorial.

Mr. A.W. Locke read a paper on the Gradual Abolition of Highway Grade Crossings, and had lantern views exhibited showing grade crossings, gates and bridge structures, etc., here and abroad. A discussion followed in which J. W. Ellis, A. F. Noyes, F. H. Snow, Fred Brooks, G. A. Kimball and others participated.

Engineers' Society of Western Pennsylvania.—At the regular monthly meeting in Pittsburgh, September 20, resolutions in regard to the death of William Thaw, Jr., were adopted. It was announced that the Society's quota for the fund for the Engineering Congress at the Columbian Exposition had been raised.

Mr. Gustav Kaufman read a paper on the Reconstruction of the Ninth Street Bridge in Pittsburgh, giving some interesting details. This paper was discussed by a number of members present. In the course of the discussion reference was made to the old tubular bridge at Brownville, Pa., which was built in 1822, and is believed to be the first tubular bridge built in the United States.

THE regular meeting of the Chemical Section was held in Pittsburgh, September 27. Dr. Charles B. Dudley delivered an address on Causes of Discrepancy in Chemical Analysis. He thought there were four possible causes.

1. Non-uniformity of Samples. This trouble could be discovered by exchange of samples.
2. Impure Chemicals. Chemists in cases of dispute should exchange samples and chemicals both.
3. Poor Manipulation. This can generally be discovered if the two chemists work together.
4. Faulty or Varying Methods. The adoption of uniform methods would be very desirable. He quoted from a well-known professor who used to say: "No chemist has ever made an *accurate* analysis. Some chemists can *work close enough to accuracy*, so that their work is valuable."

Western Society of Engineers.—At the regular meeting, September 27, a number of Committee reports were presented and acted upon after discussion. A letter from the American Society of Civil Engineers was read asking for assistance in the work of obtaining papers for the Engineering Congress next year. No papers were read, the meeting being held to dispatch accumulated business.

Civil Engineers' Society of St. Paul.—At the regular meeting of October 3 some routine business was transacted. Messrs. William R. Mansel, John S. Beeston, and Charles A. Hunt were elected members of the Club.

Engineers' Club of St. Louis.—The first meeting of the season was held in St. Louis, September 21. The question of changing quarters and securing permanent accommodations was made the regular order for the next meeting.

Professor W. B. Potter then read a paper on Water Supply for Large Cities, showing how the supply was affected by the water shed and describing in detail the nature and character of the impurities found in rain, surface, ground and deep water. A number of tables were exhibited showing the sources of the water supplies of the larger cities of the country.

Discussion followed by Messrs. Flad, Johnson, Seddon, Potter, Wheeler, Crosby and Russell.

AT the regular meeting of October 5 the question of new quarters for the Club was generally discussed, without final action. An amendment to the by-laws was submitted.

Mr. Ockerson exhibited a series of blue prints showing the changes in the Mississippi River channel for the last 12 years.

Mr. Melcher exhibited a number of blue prints and photographs of the Lidgerwood machinery.

Civil Engineers' Club of Cleveland.—The September meeting of the Club was held in the club rooms, September 13. Willard Fuller was elected an active member.

Professor C. H. Benjamin, of Case School of Applied Science, read a paper on Some Experiments on the Effect of Punching on Soft Steel. The experiments described were made at the mechanical laboratory of Case School of Applied Science.

Central Railroad Club.—A meeting was held in Buffalo, September 28, at which a report was received from the Committee appointed to confer with the Superintendents' Association concerning the delivery of cars consigned to local points which are in bad order, but not unsafe to run. After considerable discussion the Club voted to notify the Superintendents' Association, that in its opinion cars for local points bearing M. C. B. defect cards should be accepted if not unsafe to run to their destination, provided they bear an additional card directing their return empty.

Western Railroad Club.—The annual meeting was held in Chicago, September 20, when the reports of the officers were presented and the following officers were chosen for the ensuing year: President, W. H. Lewis; Vice-Presidents, A. M. Waitt and William Forsyth; Treasurer, Allen Cooke; Secretary, Waldo H Marshall.

After the adjournment the Club accepted an invitation to visit the buildings of the Columbian Exposition.

Northwest Railroad Club.—The first meeting of the season was held in St. Paul, Minn. September 13. Mr. J. C. Halladay read a paper on the subject of Car Heating by Steam, which was illustrated by the models of the Consolidated Car Heating Company's apparatus. This was followed by some discussion.

Roadmasters' Association of America.—The Secretary announces that the dates upon which the next convention of this Association will be held have been changed to November 15, 16 and 17, on account of the large number of members of the Association who are employed on roads centering in Chicago, and who, owing to the immense traffic over their lines before and after the Columbian Exposition opening ceremonies, cannot leave their posts of duty.

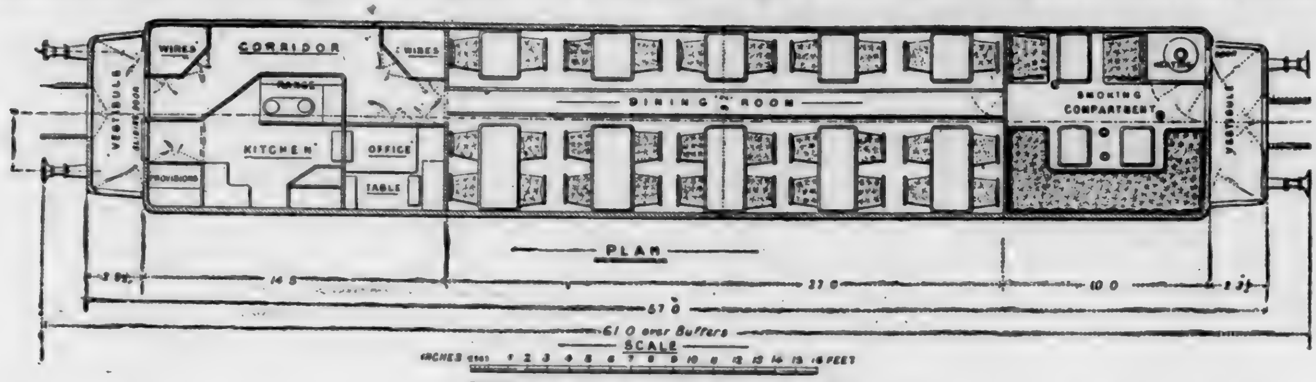
The convention will accordingly meet in Chattanooga, Tenn., November 15, and will adjourn to Atlanta, Ga., on the following day.

NOTES AND NEWS.

European Dining Cars.—The diagram herewith, from the London *Engineer*, gives a plan of one of several dining cars recently built by Brown, Marshalls & Company, at Birmingham, England, for the Compagnie Internationale des Wagons-Lits et des Grands Express Européens of Paris. They are intended to run in connection with the Indian mail train from Calais to Brindisi, meeting the Peninsula and Oriental steamers. The carriages are 61 ft. long and 9 ft. 2 in. wide. The dining-room in each car is arranged to seat 30 persons at 10 tables, five of which are for four persons each, and the other five to accommodate two persons each. At one end of the dining-room a swing door opens into a luxurious smoking-room furnished with sofa and easy-chairs to accommodate seven passengers.

The partition between the dining and smoking-rooms has panels of beveled glass; the other ends of the dining-room and smoking-room are ornamented with beveled mirrors. The partitions and side walls are of polished teak, with fielded panels and moldings. The tables are of light oak covered with linoleum, the ceilings being of figured oak in three thicknesses elaborately hand-painted with arabesque ornament, fruit and game, and bordered with ornamental teak moldings. The roof is of the "monitor" shape, fitted with windows glazed with colored glass, opened by means of handles to allow of ample ventilation, and protected on the outside by fine copper wire gauze. The saloons are lighted by gas chandeliers. The windows

open at the top and slide in brass grooves, the frames being edged with velvet to prevent any rattle, and strips of India-rubber are placed over all joints to exclude drafts. The windows are all provided with spring roller blinds. The floor, which is of white pine, is covered first with a thick layer of felt, then with linoleum, and on this is laid a Wilton pile carpet, and along the gangway between the tables is a narrow carpet of hair and worsted. Electric bells are fitted, each table having communication with the pantry. At the opposite end of the dining-room there is a swing door opening into a long corridor, off which are the compartments for the servants—namely, the pantry, kitchen, wine cupboards, etc. The pantry has double doors, and is provided with tables, cupboard, shelves for glasses, ice-boxes, and wash-basin. The two wine cupboards open off the corridor, and are fitted with refrigerators, and have ample room to carry enough wine for the double journey. The kitchen has a sliding door opening from the vestibule at the end of the corridor; at the side of the door is a large cupboard fitted up with shelves; in this cupboard a refrigerator is fixed. The kitchen is furnished with a cooking range, copper, hot and cold water tanks, sinks for hot and cold water, pump for filling the tanks, and all the necessary hooks for kitchen utensils. The kitchen is lined throughout with sheet iron, interlined with asbestos sheets to make the whole fireproof. The carriages are heated throughout with hot-water apparatus, and the furnace is accessible from the vestibule at the smoking-room end; the pipes are of copper, and run along the sides of carriages under the tables. At each end of the carriage there is a covered vestibule, with a door at each side opening on to the steps. The carriage is built on a composite wood and steel underframe, the outside longitudinal timbers being strengthened by Siemens-Martin steel channels in one piece the whole length, and bent at each end to the shape of the covered platform. Each carriage is mounted on two four-wheeled bogies made of iron with oak bolsters. The wheels are the Arbel solid pressed pattern with crucible steel tires. The carriages are fitted with the Westinghouse automatic brake; the vacuum and Smith-Hardy brakes are also provided on the carriages, so that they can be worked over the various railroads on the Continent. The saloons are built to the designs of M. Felix Gain, Engineer of the Compagnie Internationale.



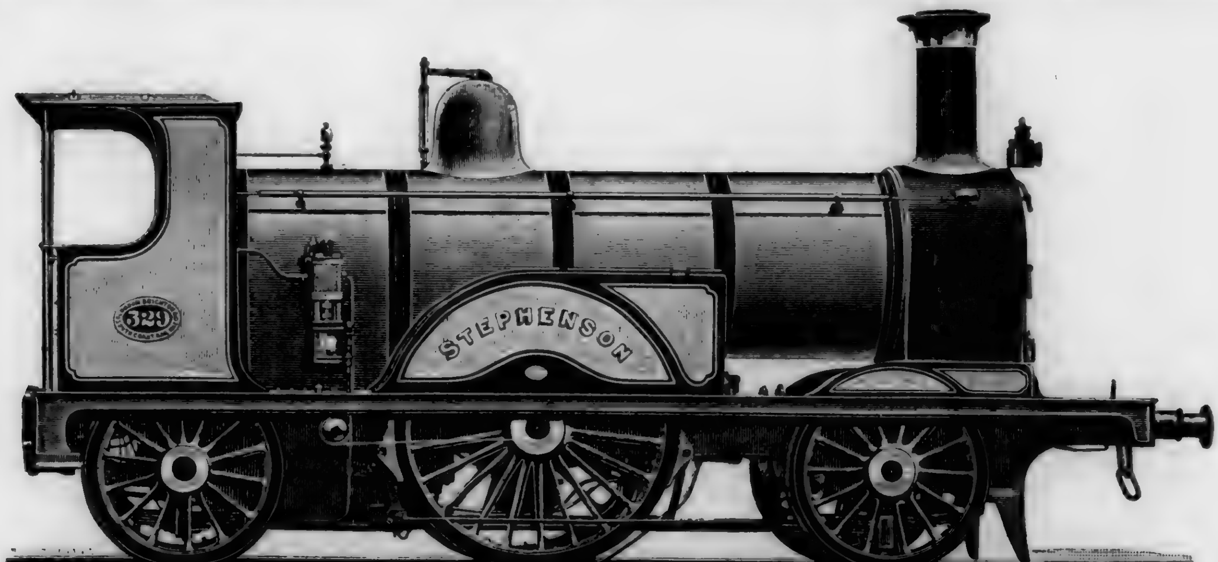
GENERAL PLAN OF EXPRESS DINING CAR

An English Express Locomotive.—The accompanying illustration, from the *Railway Engineer*, shows the standard express engine of the London, Brighton & South Coast Railway. In this engine, designed by the late Mr. William Stroudley, the older style of English construction has been closely adhered to.

The engine is carried on six wheels, having a single pair of drivers. The leading and trailing wheels are 54 in. and the driving wheels, 78 in. in diameter. The cylinders, which are 17 in. in diameter and 24 in. stroke, are placed inside. The steam ports are 15 × 1½ in. and the exhaust ports 15 × 2½ in. The valves have 3¾ in. maximum travel, ⅞ in. outside lap and ⅛ in. inside lap. The valve motion is the ordinary shifting link.

The boiler is 51 in. in diameter, and has 262 tubes 1¾ in. in diameter and 10 ft. 6 in. long. The fire-box is of copper. The grate area is 17 sq. ft., and the heating surface is: Fire-box, 100; tubes, 1,084; total, 1,184 sq. ft.

The total weight of the engine is 74,800 lbs., of which 30,250 lbs. are carried on the driving-wheels. The total wheel-base is 15 ft. 11 in. The tender is carried on six wheels, and has a capacity of 2,250 galls. of water and 2 tons of coal. It is stated that the average train hauled by engines of this class is about 110 tons, and that the average coal consumption is about 29 lbs. per train mile.



EXPRESS LOCOMOTIVE FOR THE LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

Engines of a Modern Battle-Ship.—In our last issue we commented upon the "voluminous" outfit of a modern war vessel, and since then applied to Mr. George W. Dickie, manager of the Union Iron Works in this city, for particulars respecting the number of steam-engines on the battle-ship *Oregon*. Mr. Dickie has sent the following list, set down from memory, which is here arranged in tabular form:

Number of Engine Cylinders.	Purpose of Engines.	Characters of Engines.	Diameter of Cylinders in Inches.	Stroke in Inches.
6	Main Driving, 9,000 H. P.	Triple	34½″, 48″, 75″	42″
4	For Air Pumps	Double	6″	12″
4	For Circulating Pumps	Compound	7″, 12″	6″
2	Hot Well Pump Engines	Single	8″	16″
2	Fire and Bilge-Pump Engines.	Single	10″	16″
2	Air and Circulating Pumps	Single	10″	16″
4	Ventilating Fans	Compound	5″, 9″	6″
4	Barring Engines	Double	6″	6″
2	Reversing Engines	Single	14″	18″
4	Hydraulic Steering Gears	Double	8″	12″
4	Main Feed Pumps	Single	12″	16″
4	Auxiliary Feed Pumps	Single	10″	16″
8	Ash Hoisting	Single	5″	6″
16	Fire-Room Fans	Compound	5″, 9″	6″
4	Steam Cranes	Double	8″	10″
12	Hydraulic Pumping	Single	20″	30″
8	Steam Winches	Double	8″	10″
2	Windlass Engines	Double	16″	12″
8	Dynamo Engines	Compound	7″, 12″	6″
2	Ice Machines	Double	12″	16″
8	Ventilation	Compound	5″, 9″	6″
1	Distilling Room, Air	Single	10″	12″
1	Water and Brine	Single	6″	10″

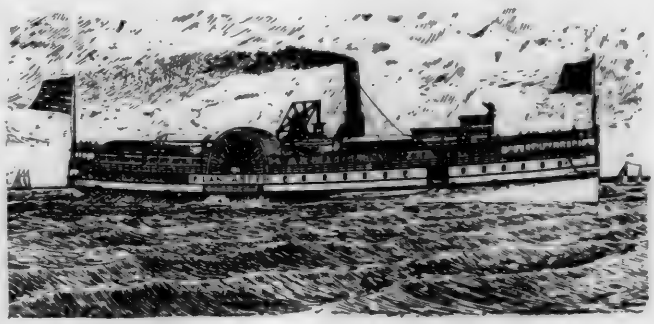
Besides this list, making 112 engines, counting each steam cylinder, there are some connected with the torpedo service, the dimensions of which are not yet determined. After looking over this list one will conclude that the steam machinery of a modern war-ship is the principal part. She is indeed a great magazine of machinery, much of it of a delicate nature, and all requiring intelligent care.—*Industry, San Francisco.*

Rebuilding a Pittsburgh Bridge.—At a recent meeting of the Engineers' Society of Western Pennsylvania Mr. Gustave Kaufman read an interesting paper on the Reconstruction of the Ninth Street Bridge in Pittsburgh. This bridge, finished in 1840, was originally of the Burr type of combined arches and trusses, of one span of 190 ft. and four spans of 200 ft. in the clear. The piers were 9 ft. wide on top and 35 ft. long; they had semicircular ends, thus making the total length of the piers 44 ft. The foundations of all masonry in the river were timber platforms. The price paid for the masonry was about $7 per cubic yard. The substructure cost about $37,000, and the superstructure about $33,000; with approaches the bridge cost about $80,000. The bridge was covered on all sides and top, and offered great resistance to the wind. In 1889 this bridge, which was still in a safe condition for slow traffic, fell into the control of the Pleasant Valley Electric Street Railroad Company, which at once began to replace the old structure with one that would be adapted to rapid-transit traffic purposes. The requirements of the Company were:

1. The new structure to be wide enough for four lines, two for quick rapid transit and two for slow transit; and for two sidewalks of 10 ft.
2. The old masonry to be used.
3. The old structure to be removed and traffic maintained during the erection of the new bridge.
4. The structure to be designed on strictly economical principles, and no ornaments to be used, the substructure to consist of five spans of plain Pratt trusses.
5. The load on the floor to be 12 tons on two pairs of wheels 10 ft. apart, or a uniform load of 100 lbs. per square foot. The trusses to be figured to carry a moving load of 4,000 lbs. per linear foot.

The work necessitated the building of a new abutment on the Pittsburgh side, the rebuilding of the tops of all the piers, a new pier on the Allegheny side, and an entirely new superstructure, the trusses of which are of steel, and the entire new floor and lateral system of iron. The paper describes in detail the work as performed, including the strengthening of the masonry on the old piers by the inflow of hydraulic cement; the cutting down and rebuilding the tops of the piers; the removing of the skew-backs and the building up of the piers to a uniform section between the new trusses; the raising of the bridge spans to meet the requirements of the U. S. Government Engineers.

The work was completed in the fall of 1890 without injury to any person and practically without cessation of traffic.



SIDE-WHEEL STEAMBOAT "LANCASTER," CHESAPEAKE BAY.

Two Chesapeake Bay Steamboats.—The two illustrations given on this page, which we take from *Seaboard*, show two different and contrasting styles of steamboats, both recently built in the new Sparrow's Point ship-yard, Baltimore, for service on Chesapeake Bay. Both are intended for freight and passenger service, and both have large freight capacity and handsome passenger accommodations.

The first is the *Lancaster*, a side-wheel steel boat built for the Weems Line, between Baltimore and Fredericksburg. On part of this route, up the Rappahannock River, the depth of water is not great, and a light draft boat is needed. The *Lancaster* is 213 ft. long over all, 32 ft. molded beam, 12 ft. depth and 57 ft. wide over the guards. She is propelled by paddle-wheels 30 ft. in diameter and 8 ft. face, driven by a beam engine with cylinder 48 in. in diameter and 11 ft. stroke. The valve gear is of the toe-and-lifter type commonly used with beam engines, but an adaptation of the Hackworth valve gear is used to give an adjustable cut-off. The wheel frames are of iron with cast-steel centers, and the gallows-frame carrying the walking-beam is built up of steel plates and angles. There is a surface condenser with an independent centrifugal circulating pump. There are two Scotch boilers 10 ft. 9 in. in diameter and 15 ft. 6 in. long, working at 50 lbs. pressure; each boiler has three 39-in. furnaces, the total grate area being 217 sq. ft.

PROPELLER "ALABAMA," CHESAPEAKE BAY.

The second boat is the *Alabama*, just launched, and built for the Bay Line between Baltimore and Norfolk. She is of steel and is 305 ft. long over all, 18 ft. 1 in. molded depth, 43 ft. beam and 55 ft. wide over the guards. The frames and outside plating are unusually heavy. She is propelled by a single screw 12 ft. 9 in. in diameter, built up with steel blades. This is driven by a vertical triple-expansion engine having high-pressure cylinder 24½ in., intermediate 40 in., and two low-pressure cylinders each 47 in., all being 42 in. stroke. The high-pressure cylinder has piston valves, the others slide valves. The condenser has an independent centrifugal circulating pump; the air pump is worked from the main engine. There are four boilers, each 12 ft. 9 in. in diameter and 10 ft. 8 in. long, with three 44-in. furnaces. The total grate area is 264 sq. ft. The usual working pressure is 160 lbs.

Both of these boats have electric light plants, are lighted throughout by electricity and provided with powerful search-lights. Both have steam reversing and turning gear for their engines.

Locomotives in England.—According to figures compiled by Mr. Clement E. Stretton from official returns, there are in service on the railroads of England and Wales 14,314 locomo-

tives; Scotland, 1,841; Ireland, 705; making a total of 16,860 locomotives.

The London & Northwestern Company stands first in the list, having 2,648 locomotives, and the Midland comes next, with 2,020. Three other companies have over 1,000 each, the Great Western reporting 1,660, the Northeastern 1,560, and the Lancashire & Yorkshire 1,127.

The Caledonian Company has the greatest number of any of the Scotch lines, owning 690 engines. The Great Southern & Western leads the Irish companies, having 178.

In the United States, according to *Poor's Manual*, there are 33,563 locomotives. By last reports the Pennsylvania Railroad had 1,623 and the New York Central & Hudson River 1,123 locomotives. These numbers have doubtless increased somewhat since the close of last year.

A Steam Bell-Ringer.—In the JOURNAL for April, 1887, there was published a description of a steam bell-ringer invent-

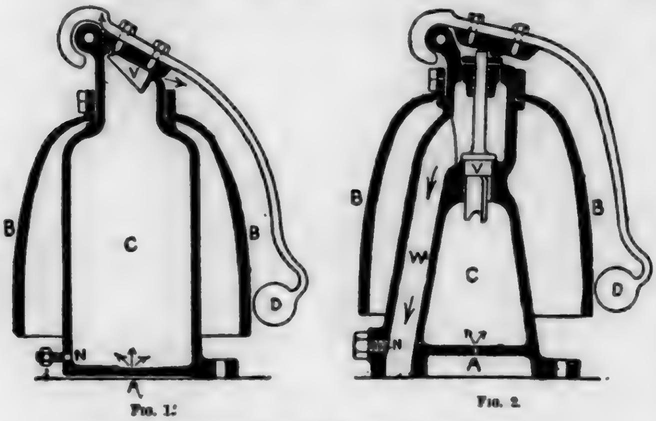


Fig. 1. Fig. 2.

LATOWSKI'S STEAM BELL-RINGER.

ed by Herr Latowski, of Munich, Germany. This device has since been somewhat modified and is now coming into extensive use in Germany. The illustrations given herewith and the description of the present form are from the *Practical Engineer*.

In the device illustrated, an effective operation of the bell is secured in an automatic manner by merely opening a steam tap, just as in the case of a whistle. The mode of action, which is as simple as it is ingenious, will be readily seen on reference to the sketch, fig. 1, and, like one or two other inventions in connection with the use of steam, is stated to have been suggested by the behavior of a common steam kettle, the loosely fitting lid of which may sometimes be observed to chatter on its seat as the steam generated within escapes in a series of puffs. The bell *B B* is arranged in the form of a cap, surmounting the chamber *C*, to which steam is admitted by means of a stop cock, through a very small opening in the bottom, at the point *A*. The top of the chamber, it will be observed, is closed with a valve, *V*, of lever construction, the loaded end *D* of which constitutes the bell clapper. It will be manifest that as soon as the steam pressure within the chamber *C* overcomes the load, the valve *V* is lifted from its seat, and as this is of considerable area the pressure is at once relieved, and it falls back again, causing the clapper *D* to strike a blow. The closing of the valve is, of course, quickly followed by another rise of pressure, when the operation is again repeated and another blow is struck, and so on in rapid rhythmic succession, so long as the tap communicating with the chamber *C* through the small hole at *A* is left open. The ringing of the bell is accompanied by a slight escape of steam in a series of puffs from the valve *V*. At *N* is a small hole fitted with a plug, to permit of the escape of any condensated water within the chamber *C*.

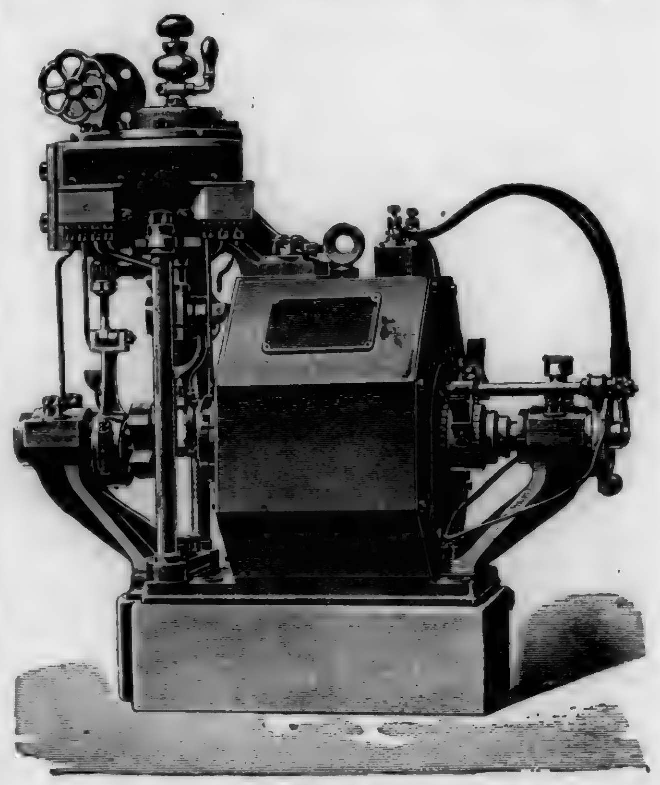
Fig. 2 shows another arrangement of the device, in which the lifting of the clapper *D* is effected through the medium of a common mushroom valve, *V*, fitted with a spindle passing through a freely fitting stuffing-box, which prevents any escape of steam from the bell interfering in any way with the outlook of the driver, the steam, instead of escaping in a series of puffs, being led away by means of the discharge-pipe *W* to the smoke-stack.

Iron Turnings in Foundation.—A very simple method of laying the foundations on a swampy location, which did not furnish a firm sub-soil, was employed, says the *Great Divide*, by an American engineer for supporting a low wooden building to be used for storage of machinery. Casks were set in holes in the ground along the line of posts, and were filled to the depth of about one foot with iron turnings. The posts were set in casks, which were then filled with iron turnings compactly rammed in place. A solution of salt and water was then slowly poured over these turnings, which compactly solidified into a hard mass. The heat of the oxidation of the iron was so great that the posts smoked and were charred, the latter fact probably being the reason why they have not as yet exhibited any signs of decay, and in this respect the use of iron turnings furnishes an advantage over the use of concrete for cask foundations.

Iron Roads.—An engineer writes to the Pittsburgh *Dispatch*, referring to the great cost of making stone or gravel roads in many places, claiming also that in many parts of the country the stone road would be impossible, as the hauling of the stone to it would wear out more than the load would make. In fact, he thinks there is not enough of available road-making stone in the United States to accomplish the task. Aside from this, he believes that the stone road is behind the age. Superior as it is to the common dirt road, it is almost as far behind the iron track as the dirt road is behind it. He says the railroad, street car track and the tramway all point the way of the future road. The track for the wheel must be of iron. It is the only material that is unyielding to the wheel, and smooth. He advocates the laying of iron beams from 6 to 8 in. wide slightly concaved. He says it can be done for one-third the cost of macadamized road, and, even without providing any better footing for the horse than now exists, it will work a revelation in traffic.

The idea is not a new one by any means, but might be available where iron is to be had at a low rate and stone is not accessible.

A Small Steam Dynamo.—The usual practice in designing a direct-driven dynamo is to take an ordinary engine and an ordinary dynamo and to couple them together. This produces a rather clumsy result. More recently the engine has been made with a prolonged or altered bed-plate, so that the dynamo can be mounted on it. The dynamo thus becomes a sort of attachment to the engine. In the steam dynamo, which we illustrate, the reverse practice has been followed—the engine is a mere attachment to the dynamo. It will be observed that the dynamo has its bed-plate carried out a few inches further than usual, and the bearing bracket projects out. The thrust of the



COMBINED DYNAMO AND ENGINE.

engine is taken by two light wrought-iron pillars, and the cylinder is cast with a bracket, which is bolted to the field magnets. The floor space required is no larger than if the dynamo had a pulley for belt driving. The little engine is specially designed to be suitable for ship lighting. The dynamo itself presents no remarkable features, being a four-pole machine of a type that is very common in Germany. The maker is Herr Gustav Conz, of 45a, Spaldingstrasse, Hamburg.—*Industries.*

THE RAILROAD AND

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(ESTABLISHED IN 1832.)

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NEW YORK, DECEMBER, 1892.

ANNOUNCEMENT.

ON the completion of the present volume of the RAILROAD AND ENGINEERING JOURNAL, and beginning with the number for January, 1893, the title under which it has been published since 1887—when the old *American Railroad Journal* and *Van Nostrand's Engineering Magazine* were consolidated—will be changed to THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

The chief reason for making this change is that the present title is somewhat cumbrous, is lacking in definiteness, and is not easily remembered. It has been found that many persons familiar with the JOURNAL, and even those who are regular readers of the paper, do not readily recall its name, and that it is often difficult to identify it by its title alone. At the time of the consolidation of its progenitors the name which would have been preferred to any other, for the new publication, was THE AMERICAN ENGINEER, but at that time a paper with that title was published in Chicago. Since then it has been discontinued, and therefore the name may now be assumed by us if we are disposed to adopt it. For the reasons given it has been determined to make use of that privilege; and although a change in the title of a periodical publication is attended with obvious—but, it is thought, merely temporary—disadvantages, it is believed that they are not so great as the detriment resulting from the continued use of a name which is not sufficiently distinctive and is difficult to recall.

It must be understood, however, that the change of name does not imply any change of control; nothing but the title of our late cotemporary has been adopted, and the ownership and the editorial staff of the paper will continue the same as heretofore.

The new name will indicate distinctly the character which this publication is intended to have. It was announced in the first number of the RAILROAD AND ENGINEERING JOURNAL that it " will be devoted to the discussion of engineering and mechanical subjects. Railroad construction and operation being, however, the most important branches of engineering in this country, more space will be devoted to them than to any other one department of engineering." The general scope of the paper under its new title will not be materially changed. Its form and size will remain the same, but new type and a quality of paper better suited for the printing of process engravings will be used. It is intended to have a larger proportion of original articles than heretofore, and to make material improvements in the character of the illustrations published.

Among the articles already provided for, it may be mentioned that Dr. Dudley's interesting series of Contributions on Practical Railroad Information will be continued; and Mr. Chanute's on Progress in Flying Machines will also be continued and concluded. Fully illustrated descriptions of locomotives, cars, stationary and marine engines, shop appliances and practice by different builders will be given from time to time.

A series of articles on what may be called Comparative Anatomy of English and American Locomotives will be commenced in the January number. These will be illustrated by very complete detailed engravings showing the construction of the engines and of the different parts or organs of the most recent express locomotives built for the London & Southwestern Railway, and of the engine with 7-ft. driving-wheels now running on the New York Central & Hudson River Railroad, an illustration of which was given in the November number. These illustrations will be fully described in critical articles comparing the construction and performance of both engines. This discussion will be continued through the greater part of the year 1893, and will, it is thought, give a better idea of the peculiarities of construction of both English and American locomotives than it is possible to obtain from any existing source. Engravings of all the different parts of the two engines will be printed on opposite pages, which, with the description and criticism that will be given, will greatly facilitate a comparison of the different methods of construction employed in this country and in England, and of their relative advantages or disadvantages.

Other new features will be added to the paper from time to time, and it will be the aim of its editors and proprietor to make the rechristened paper such a record of the work of the AMERICAN ENGINEER as shall be a warrant for the use of that title.

EDITORIAL NOTES.

ALL subscribers to the RAILROAD AND ENGINEERING JOURNAL should receive with the present number the Index and Title-page for Volume LXVI (Volume VI, New Series). Should any fail to receive it, they can have the omission supplied on notifying this office. The volume covered by this index includes the twelve numbers for the year 1892.

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The present season, with its long drought extending through the fall, when rain is usually abundant, has been a severe test for the water works of quite a number of the smaller cities and towns of the Eastern States. Some of them have stood it, while a few have not, and in many cases there has been a narrow escape. It too often happens with towns of moderate size that, while the works themselves are well planned, not enough care is taken to investigate the sources of the water supply or to provide storage for a dry season. The supply is good at first, perhaps for two or three years, but a long drought comes, the source fails, and the resulting expense is greater by far than would have been required for a proper provision in the first place. Instances enough could be given, and in one case in mind a rapidly growing suburban town has lost by a check to its increase and a corresponding depreciation of property more than ten times the amount that a proper system with a sufficient supply would have cost.

The enlargement of the Chesapeake & Delaware Canal so as to permit the passage of large sea-going vessels through its locks is urged by Professor Haupt, with much force in an article quoted in another column. There are few improvements of equal extent which could be made for so small a sum, and which would yield so valuable a return. In connection with the proposed ship canal between New York Bay and the Delaware and the enlargement of the canals south of Norfolk, it would furnish a waterway which will certainly be of great service to commerce, and which might be of inestimable value in case of war.

The armor for the barbette of the *New York* has now been tested and accepted, and it is said that work on her completion can proceed without further delay.

The coast defense ship *Monterey* at San Francisco will be ready for the trials of her engines in December. She is the first large ship of the Navy in which a large part of the steam power is furnished by tubulous boilers.

It is claimed that the best time on record was made on the evening of November 18 on the Central Railroad of New Jersey by one of the large Vauclain compound passenger engines, which were illustrated and described in the Journal for June last. On the evening in question the engine, running with a regular train, consisting of a combination car, two day coaches and a Pullman car, ran one mile, near Fanwood, N. J., in 38 seconds, and the succeeding mile in 37 seconds; or at the rate of 94.74 and 97.30 miles per hour respectively. The engine had previously made a mile in 39 seconds. At the time of the run there was a high wind.

The electrical engineers are indirectly responsible for a number of recent improvements in the steam-engine. The demand for quick-running and reliable engines for working dynamos for electric lighting and similar purposes has stimulated the activity of engine-builders, and been the occasion for improvements of different kinds. This state of affairs promises to continue for some time to come.

The use of the compound and triple-expansion engines and of higher boiler pressures has had a tendency to increase the use of water-tube, coil and other similar forms of boilers. The influence of this can be traced in the number of patents for such devices recently patented, and in other similar ways. The tubulous boiler will undoubtedly have a very large part among the steam producers of the future, and any improvements in its design and structure are welcome.

Our electrical friends have also stimulated the construction of dams and the utilization of water-powers. Many water-powers are situated in remote places where it is difficult or impossible to build mills, or if sites can be found, the cost of haulage to and from the mill would be a source of too great expense. But with late improvements in electrical transmission it is only necessary to find room enough for the water-wheel and dynamo, and the power can be taken to any convenient point.

The builder and designer of great bridges find in Russia almost as wide a field to work in as in this country. In the size of the rivers and, in fact, in many of the physical features, that country bears a considerable resemblance to the United States. We find, as might be expected, that many bridges of great length have already been built there, and others are projected. In many respects American practice in bridge-building has been closely approximated, and Russian engineers do not hesitate to acknowledge their obligations to their American brethren.

It may be added that the Siberian Railroad, when completed, will have some of the largest bridges in the world.

In no country has irrigation been so carefully planned and so widely practised as in British India. Irrigation works have existed there for many centuries, and have more recently been extended under English engineers. Some of the largest rivers have been dammed either to divert their flow or to furnish storage, and there are dams in that country far exceeding in size anything yet planned here. Some of these works approach three miles in length, and there are a number of almost equal dimensions. On another page will be found an account of some of these structures.

PROPERTY IN IDEAS.

A very little experience in life or study of history or human nature soon teaches us that the predatory passion in mankind is very strong, and the command, "Thou shalt not steal," although it was promulgated some thousands of years ago and has been zealously inculcated ever since, has, up to this time, not made hen roosts inviolable, strong boxes unnecessary, or given to railroad and other securities the character implied by their name. It is true that among civilized people only the very ignorant and vulgar steal chickens; but bank robbers are of a higher grade of intelligence, and are regarded as more respectable. Those who wreck railroads often move in the higher walks of society, and are not entirely excluded from the Church. If a person steals a material thing of little value he is a vulgar thief; if he carries away money, he is a daring robber; and if he unjustly transfers the title of property to himself, he is a shrewd operator. In all these cases the thief gets possession of material property by predacious means, and the degree of infamy which is attached to the act somehow seems to be in the proportion which the materiality of the thing stolen bears to its value. If there is much material and little value, as in the case of chickens, the theft is considered very reprehensible and vulgar. If there is little material stolen, as in the case of money or

jewels, and much value, it is somewhat less disgraceful; and if no actual material thing is carried away, but only a title to something is taken, many people are prepared to condone the offense and admire the shrewdness of the malefactor. To a still greater extent does this feeling exist when we deal with property in ideas. There are not many *raconteurs* who are scrupulous about telling other people's good stories or clever sayings as their own, and what a man writes is considered public property unless the author can protect his rights by the authority of the copyright laws. In fact, the recognition of the right to intellectual property implies a more than ordinary development of the mental and moral faculties. It has been said, and many people think, that there is no natural property in ideas which are evolved from the depths of the inventor's or author's consciousness; and these cheap and miraculous products should therefore be at the disposition of all who may desire them for their own use. Or, as Herbert Spencer says: *

There are not wanting philanthropic and even thinking men who consider that the valuable ideas originated by individuals—ideas which may be of great national advantage—should be taken out of private hands and thrown open to the public at large.

To this an inventor might fairly reply: "Why may not I make the same proposal respecting your goods and chattels, your clothing, your houses, your railway shares, and your money in the funds? . . . True, as you say, this capital, on the interest of which you subsist, was acquired by years of toil—is the reward of persevering industry. Well, I may say the like of this machine. While you were gathering profits I was collecting ideas; the time you spent in conning the prices current was employed by me in studying mechanics; your speculations in new articles of merchandise answer to my experiments, many of which were costly and fruitless; when you were writing out your accounts I was making drawings; and the same perseverance, patience, thought and toil which enabled you to make a fortune have enabled me to complete my invention. Like your wealth, it represents so much accumulated labor; and I am living upon the profits it produces me just as you are living upon the interest of your invested savings. . . . If I have no right to these products of my brain, neither have you to those of your hands; no one can become the sole owner of any article whatever, and 'all property is robbery.'"

The same author says "that a man's right to the produce of his brain is equally valid with his right to the produce of his hands is a fact which has yet obtained but a very imperfect recognition."

It is often objected to patents that they are "monopolies." The word "monopoly" is derived from two Greek words meaning *alone* and *to sell*, and signifies "the exclusive right to sell." A writer on patent law † defines a monopoly as "a franchise created by the Government, and vesting in an individual or corporation the exclusive privilege of practising a certain art, or of making, using or selling a certain article, which but for such monopoly all other individuals and corporations would be at liberty to practise, or to make and use and sell." Such monopolies were granted in monarchical governments as rewards for service rendered, and in this manner nearly all commercial operations eventually became restricted under the protection of such exclusive grants; and as another writer on patent law ‡ says: "In the grants of the crown the subject-matter of the exclusive privilege was quite as often a commodity of which the public were and long had been in possession as it was anything invented, discovered, or even imported by the patentee." When an exclusive franchise is granted to an inventor, instead of taking anything from the public, he confers on it the greatest benefits. Judge McLean, in a decision made in 1855, said that:

Patentees are not monopolists. This objection is often made, and it has its effect upon society. The imputation is unjust and impolitic. A monopolist is one who by the exercise of the sovereign power takes from the public that which belongs to it, and gives to the grantee and his assigns an exclusive use. On this ground monopolies are justly odious. It enables a favored individual to tax the community for his exclusive benefit, for the use of that to which every other person in the community abstractly has an equal right with himself. Under the patent law this can never be done. No exclusive right can be granted for anything which the patentee has not invented or discovered. If he claims anything which was before known his patent is void. So that the law repudiates a monopoly. The right of the patentee entirely rests on his invention or discovery of that which is useful and which was not known before. And the law gives him the exclusive use of the thing invented or discovered for a few years as a compensation for his ingenuity, labor and expense in producing it. This, then, in no sense partakes of the character of a monopoly.

The ground upon which patents for inventions are granted was very clearly stated by an English judge as long ago as 1602, who said:

That when any man by his own charge and industry, or by his own wit or invention, doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before—and that for the good of the realm—that in such cases the king may grant to him a monopoly patent for some reasonable time until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth; otherwise not.

That there are some great abuses which are carried on under the protection of the patent laws is true; but this is the case with all laws, and there has been for years past a very strong opposition to all patent laws. This opposition has come from large corporations, who want freedom to use the inventions of others without paying for them, and from a part of the agricultural communities in the West, who have had some unjust demands made on them for the use of patents, and also have had the feeling that agricultural machinery and other products would be cheaper if they were not patented. The question comes up perennially whether it is wise and just for the Government to stimulate the exercise of inventive talent, or, in the words of the Constitution of the United States, "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors the exclusive right to their respective writings and discoveries." An answer to this inquiry may be given by asking what object inventors would have to invent if they could not have exclusive possession and control of their inventions? In other words, if there were no patent laws, inventors would stop inventing. To quote from a writer * on "The Nature of Intellectual Property:" "Whatever serves to increase that element of eager foresightedness that keeps men exploring every dark place in the line of social advance for the means of good or the remedies of evil that may be found there adds to the rate at which it gains on the difficulties which beset its advance." The patent law offers to original discoverers or inventors certain exclusive rights to their inventions and discoveries. This is a perpetual stimulant to those whom Mr. Shaler says "are stamped by nature with the fitness therefor, and have the capacity for great fixedness of attention and the training in imagination or suggestiveness which is required in order to meet the continued difficulties of an advance into unknown paths. . . . To retain this spirit of experiment and investigation which lies at the bottom of our Ameri-

* "Social Statics."

† William C. Robinson, LL.D., "The Law of Patents."

‡ Curtis on Patents.

* N. S. Shaler.

can inventiveness, we must, in the first place, *maintain the inducements that lead men into this* sort of life. These inducements are the monetary prizes that it affords." It would seem as though the progress of the English-speaking nations, but especially ours, and the development of inventions here would be a great object lesson to prove the indebtedness that civilization owes to the systems of patent law which exist in these countries.

"It is a well-proved fact," Herbert Spencer says in the book already quoted from, "that that insecurity of material property which results from general dishonesty inevitably reacts to the punishment of all. . . . From general distrust spring general discouragement, apathy, idleness, poverty, and their attendant miseries, involving alike all grades of men. Similar in kind and less only in degree is the curse attendant upon insecurity of property in ideas. Just in so far as the benefits likely to accrue to the inventor are precarious will he be deterred from carrying out his plans."

A recent book * contains what Mr. Spencer calls a "strong illustration of the fact that the moral sense, when unguided by systematic deduction, fails to find its way through the labyrinth of confused opinion to a correct code of duty." In the book referred to the author said that in 1840 he took out a patent for steeling the surface of rails and tires, and adds :

> This patent did not pay me during the whole of its time more than between £5,000 and £6,000, and I found so much trouble connected with it and the false position I felt placed in with our own company that I never took out another, nor do I ever approve of engineers who have to advise large companies being themselves interested in patents. I look upon the patent law as a great curse to this country. It cannot be worked with perfect honesty. (What law can ?) Patents are taken out for all kinds of absurd things, and by people with little or no practical knowledge of the work they undertake, and the really practical man in carrying out his work is met at all points by the claims of some patentee. I have in my practice constantly found the disadvantage of the law, not that I object to reward a man for a real invention, but the real inventors are rare, while the patents are counted by thousands. The absence of a patent law would not retard invention. The human mind will scheme and study for the pleasure of the work, and the honor of being the originator of a real improvement would be a sufficient stimulus.

That Sir Daniel may have felt placed in a "false position" with his company, which he was paid to advise, if he recommended the use of his own patented invention can easily be understood ; and he was also right in not approving of engineers who have to advise large companies being themselves interested in patents, especially for inventions they must advise about. A consulting engineer certainly ought not to "blind his eyes" by "turning aside after lucre" which might "pervert his judgment." In this respect, as in many others, he ought to "avoid the appearance of evil." It may be true, too, that so distinguished an engineer may at times, in carrying out his work, have been met by the claims of patentees, and that, from his point of view, this was a "disadvantage." Doubtless he may have encountered similar difficulties in the titles of other parties to real estate that he or his company desired to occupy, but in such cases he did not look upon the laws governing the ownership of real estate as "a great curse." He respected the rights of owners of such property, but felt it a hardship that he was compelled to regard the titles of inventors to their "property in ideas." That the human mind would scheme and study for the pleasure and honor of the work, even if there were no patent laws, may in a certain sense be true, but that they would do so with as much intelligence, energy and persistence without as they do with is surely not true.

To quote once more from Herbert Spencer :

> Did mankind know the many important discoveries which the ingenious are prevented from giving to the world by the cost of obtaining legal protection, or by the distrust of that protection if obtained—were people duly to appreciate the consequent check put upon the development of the means of production—and could they properly estimate the loss thereby entailed upon themselves, they would begin to see that the recognition of the right of property in ideas is only less important than the recognition of the right of property in goods.

That a very large proportion of inventors exercise their ingenuity on matters of which they are profoundly ignorant any one who has had much to do with them will soon discover. It is not easy to see, though, how patents could be limited so as to include only those which cover devices of practical value. It is true that the law says an invention must be new and *useful* ; but who shall decide on the usefulness of all the contrivances which are patented weekly ? It may be that in the future the courts and the laws may make a stricter application of the limiting word "*useful*," and that an inventor may be compelled to show the usefulness of his invention before a patent is granted. It is true, too, that there is a constant stream of frivolous inventions issued by the patent office, and that much intercourse with inventors will not increase one's estimate of their wisdom ; but with all the defects in the system, the fact remains that it has the effect—which it was intended to have—of stimulating invention, and that modern civilization owes a great deal to the recognition of property in ideas.

THE ROAD QUESTION.

A NEW petition to Congress is now being widely circulated for signature. It has been started by Colonel Albert A. Pope, of Boston, who has been very active in urging discussion of the road question, and in preaching the Gospel of Good Roads, and asks for the establishment in Washington of a Department of Roads, a permanent exhibition and an institute for the instruction of engineers in road work.

Without intending to diminish at all the importance of improving our roads—which we have always strongly urged—it seems that this petition asks too much. The Agricultural Department might well establish a special bureau to aid in road improvement and to co-operate wherever possible in the work now being done in the different States, and indeed there is no special work to which its activity could be better directed ; but there does not appear to be any occasion for setting up the machinery of an entire department with a secretary at its head. Moreover, the question is under State regulation, and too much bureau interference might do more harm than good.

To the collection of a permanent exhibition of road machinery and methods there can be no possible objection ; but this could readily and properly be done under the charge of the Agricultural Department with but little additional legislation. Under proper management such an exhibition could be made of much service.

To the establishment of an institute for the instruction of road engineers it would seem also that valid objections could be made. It is not the proper business of the Gov-

* "Diaries of Sir Daniel Gooch, Bart."

ernment to train up engineers, with the exception of the few who are needed for the special purposes of the military and naval establishments. It is, unfortunately, true that too many engineers from our present technical schools know little or nothing about road work, but an appeal to Congress is not the proper remedy. The continuation of the present agitation and discussion of the question will do much by drawing the attention of the technical schools to the fact that they have, with some honorable exceptions, neglected the question, and by showing engineers themselves how wide a field there is opened to them in road construction if they possess, or will acquire, the necessary knowledge.

The agitation of the road question should be continued, and support is due to every proper effort to further it; but the petition referred to certainly seems a step in a wrong direction, to which attention should be called.

RAILROADS OF THE WORLD.

FROM a paper presented at the recent meeting of the International Railroad Congress, it appears that at the beginning of 1891, the latest date to which all the necessary statistics could be procured, there were 617,285 kilometers —383,581 miles—of railroad in operation in the world.

America is the continent which has reached the greatest development in this direction, having no less than 54 per cent. of the railroads of the world. The United States had 268,400 kilometers; Canada, 22,531, and the Argentine Republic, 9,000.

Europe has 36 per cent. of the railroad mileage. In that continent Germany leads with 42,869 kilometers; France is second with 38,895; Great Britain third with 32,297; Russia fourth with 30,957, and Austria-Hungary fifth with 27,113 kilometers. If the ratio of railroad mileage to the number of inhabitants is taken, however, the European countries rank very differently. Sweden stands first, having 16.8 kilometers to 10,000 population, and Switzerland comes second with 10.9 kilometers to 10,000 people. France, Denmark, Germany, Belgium and Great Britain are not far apart, their ratios being respectively 9.6, 9.4, 8.7, 8.6 and 8.5 kilometers to 10,000 persons; while Russia has only 3.2 and Turkey 2.0 kilometers to 10,000 inhabitants.

The great continent of Asia has only 5½ per cent. of the world's railroad mileage, and this is chiefly concentrated in a few countries. Outside of the railroad system of British India, 27,000 kilometers, some 2,300 kilometers in Japan and the Russian Trans-Caspian line of 1,450 kilometers, we find only 1,310 kilometers in the Dutch colonies, 200 kilometers in China, and a few scattered lines in the French, Spanish and Portuguese colonies.

Africa, like Asia, has its railroads concentrated in a few countries. Algeria and Tunis have 3,100 kilometers; the Cape Colony, 3,000; Egypt, 1,544; Natal and the Transvaal about 600. The "Dark Continent" can claim only 1½ per cent. of the total.

The railroad mileage of Oceanica, with the exception of a short line in the Hawaiian Islands, is found entirely in Australia and the adjacent islands. The total is 3 per cent. of all the railroads in the world.

The total amount of capital invested in railroads is estimated at $32,600,000,000; an average of about $85,000 per mile.

NEW PUBLICATIONS.

THE FINANCIAL SECURITY OF LOCAL RAILROAD CONSTRUCTION IN AUSTRIA. By Sigmund Sonnenschein. Vienna, Austria; A. Hartleben.

In Austria, as in nearly all the other countries of Europe, there has been for two or three years past much discussion over the building of local or secondary railroads. The term by which these roads are described has hardly come into use in this country, though we long ago accomplished the fact, and all our leading roads have large systems of branch lines and feeders auxiliary to their main trunks. In Europe, however, it seems to be thought necessary that a fixed system for the building and management of such roads should be established and formulated on a distinct basis. Both plans, perhaps, have advantages of their own.

Mr. Sonnenschein's little book gives some interesting facts in relation to the local roads of Austria, and treats of their claims as an investment for capital. He has collected much information as to the working of those already established, and his book may present some points of interest to managers who have to deal with lines of this class.

THIRD ANNUAL REPORT ON THE STATISTICS OF RAILROADS IN THE UNITED STATES TO THE INTERSTATE COMMERCE COMMISSION. Henry C. Adams, Statistician to the Commission. Washington; Government Printing Office.

In the JOURNAL for February last there was published from advance sheets some extracts from this report, with tables of general statistics and an account of the method adopted by the Statistician for grouping the figures by divisions covering various sections of the country. The complete report has now appeared in a bound volume containing 984 pages, or nearly twice as many as the report for the preceding year.

The number of railroads included shows that the Interstate Commission is now receiving reports from substantially all the railroads in the country. We have frequently referred to advantages of having such statistics collected by official authority, and to the opportunity offered of giving such a general view of the railroad business of the country as had not heretofore been possible. To a certain extent the report does take this opportunity; but, unfortunately, much is lost by the late date at which it appears. The present volume only covers the year ending June 30, 1890, so that its figures are over two years old, and of the time that has elapsed we have no information. The collection and tabulation of reports are very slow processes, it is true, but it is to be hoped that the force at the command of the Commission may be so increased as partly to remedy this.

In many respects the tables are well arranged and the information given is as full as possible. The collection of figures for any one road from the report is, however, a slow work, as a number of tables must be gone over in each case.

Apart from these defects, the report has great value, and the succeeding years are likely to increase this, as improvements are made with each volume.

SIMPLE LESSONS IN DRAWING FOR THE SHOP. By Orville H. Reynolds, Chief Draftsman Northern Pacific Railway. Terre Haute, Ind.; the Debs Publishing Company.

This little book belongs to the class of what are called "practical" books. It is 4¼ × 6¼ in. in size, and contains only 83 pages. The exercises and examples are all good, but the directions are hardly full enough to serve alone as a guide to a learner of mechanical drawing. If, however, a youthful aspirant for mechanical fame begins with this book, he may be led to further knowledge. In the hands of an apprentice it will in this way have the effect of awaking an ambition for more knowledge of the subject of which it treats, and that will then be an

important point gained. The instruction in it is all good as far as it goes, but there is not much of it.

A TREATISE ON HIGHWAY CONSTRUCTION. *Designed as a Text-book and Work of Reference for all who may be Engaged in the Location, Construction or Maintenance of Roads, Streets and Pavements.* By Austin T. Byrne, C.E. Illustrated, 723 pages; price, $5. New York; John Wiley & Sons.

A great deal has been written about roads, streets and pavements, but most of the existing publications treat of only one branch of the subject or are fragmentary papers scattered through the proceedings of technical societies and the pages of technical journals, where it costs much time and trouble to find them. Mr. Byrne has carefully collated the great mass of existing information on the subject, and has presented the result in the present volume, which he has endeavored to make a comprehensive book of reference.

How great an amount of labor has been done and how thoroughly the subject is covered may be indicated by a list of the chapter titles, as follows: Pavements; Materials for Paving; Stone Pavements, Wood Pavements; Asphaltum and Coal Tar Pavements; Brick Pavements; Broken Stone Pavements; Miscellaneous Pavements, Foundations; Resistance to Traction; Location of Country Roads; Width and Transverse Contour; Earth Work; Drainage and Culverts; Bridges, Retaining Walls, Protection Works, Tunnels, Fencing; City Streets; Footpaths, Curbs, Gutters; Reconstruction and Improvement of Country Roads; Maintenance, Repairs, Cleaning and Watering; Trees; Staking out Work; Specifications and Contracts; Implements and Prices.

Of the 723 pages about 240 are devoted to city streets and pavements and 245 to country roads, the remainder being occupied by general topics more or less applicable to both classes of works. The book is fairly well illustrated, and a very full index adds to its value.

Upon the whole it may be said that the author has done a service to engineers and others engaged in road work by preparing this volume. It is a better—because more recent—and a much more comprehensive book than any which we have on the subject. Some slight defects may be found, perhaps, and the closing chapter on Implements might be improved; but on the whole it is a valuable book and should find a place in the engineer's library. It will also be an excellent book for road leagues and improvement associations who wish to temper their zeal with knowledge, and to know how a road should be made as well as how it ought to look when it is done. Its appearance is timely, as interest in the road question grows rapidly in many directions.

THE LOCOMOTIVE ENGINE AND ITS DEVELOPMENT. *A Popular Treatise on the Gradual Improvements made in Railway Engines between the Years* 1803 *and* 1892. By Clement E. Stretton, C.E. London, England; Crosby, Lockwood & Son.

The author of this interesting little book is a well-known writer in English and to some extent in American technical papers, and for years has been contributing information to the public relating to the early history of locomotives. The book is 5 × 7½ in., and contains 154 pages. Of course in this space nothing like a complete history of locomotives could be given. It contains 79 engravings, beginning with Trevethick's locomotive, built in 1803, and ending with Mr. Webb's *Greater Britain*, built last year.

The book can hardly be called a "treatise;" it is more properly a popular sketch of the history of locomotives, but a very interesting one. It commences with the first beginning of locomotives, and contains engravings of Trevethick's, Blenkinsop's, Hedley's and Stephenson's early engines. This period may be called the infancy of the iron horse. During this time, as the author says, "Locomotive engines had simply been employed by private colliery owners for conveyance of coal upon their own lines." In 1825 the Stockton & Darlington, the first public railway in the world, was opened for traffic. This was the beginning of the second or youthful period of locomotive development. In this part of the book engravings and descriptions are given of Stephenson's engines, *Locomotion*, *Experiment*, *Twin Sisters*, *Lancashire Witch*, Hackworth's *Royal George* and Foster, Rastrick & Company's *Agenoria*, which "was exactly similar to the *Stourbridge Lion*," the first locomotive which ever ran in this country.

The third period, or the adolescence of locomotive development, began with the celebrated Rainhill trial. The *Rocket*, *Novelty* and *Sanspariel*, the three engines which competed for the prize, are all described. These are succeeded by many illustrations of locomotives which were built soon after this trial, all of which are very interesting.

The third chapter covers the period of the "Battle of the Gauges," when the advocates of the 7 ft. and the 4 ft. 8½ in. gauges competed with each other in the speed of their trains and the size of their locomotives. It was the time when large driving-wheels were very much in vogue, and a number of these are shown in the engines which are illustrated.

Chapter IV describes and discusses Modern Locomotives for Main Line Trains. In this the principal types of locomotives now used on English lines are illustrated and described.

Chapter V is on Sundry Appliances. The steam sand blast, the injector and the Joy valve-gear are discussed here. A good index completes the work.

Altogether persons interested in locomotive engines will find it one of the most readable books on that subject which has ever been published. It is written in a popular style, which is very simple and plain. The author, happily, has avoided any attempt at fine writing, and has told the story of the wonderful development of the locomotive in a very simple and plain way. It is to be regretted, though, that the engravings are not better than they are. Some of them are "process" cuts of that ragged character which makes one regret that the "process" of producing them was ever discovered.

It would, too, have added very much to the interest and value of the illustrations of the older engines if the original source from which the illustrations have been copied had been given. Some of them obviously are not authentic. That of Stephenson's Killingworth engine, on pages 12 and 13, with connecting-rods, cross-heads and guides like spider-webs, is obviously inaccurate, as the mechanism, if made as it is proportioned in the illustration, would be impossible. The engraving of the *Locomotion*, on page 17, is plainly not a copy of an actual machine, but is made from a drawing—and a very poor one—of a "scheme." Notwithstanding these defects the book possesses so much interest that they will be excused on reading what the author has written. There is abundant room for amplification, however, and it is to be hoped that some time in the future he will give the public a more elaborate and complete history of locomotives, in which the evolution of their different organs may be described. Such a work offers a very tempting field to any writer with a knowledge of locomotive engineering and a taste for antiquarian research.

CURRENT READING.

THE November number of the JOURNAL of the Military Service Institution is an unusually full one. There are articles on Guns and Forts, by Colonel King; Cavalry Equipment, by Lieutenant Cole; Water Supply in Desert Campaigns, by Lieutenant Beckurts; Skobeleff's Last Campaign, by Captain Clark; Recruiting Experiences, by Lieutenant Hawthorne;

the New Infantry Drill Regulations, by Lieutenant Crane; Artillery Service in the Rebellion, by General Tidball; and a variety of reprints and translations.

The November number of the NORTH AMERICAN REVIEW, besides several political articles, gave its readers papers on the Scandinavian in the United States, by Professor Boyesen; What Cholera Costs Commerce, by Erastus Wiman; Waste Products Made Useful, by Lord Playfair; Quarantine at New York, by Dr. Jenkins; Ernest Renan, by Robert G. Ingersoll; and several minor papers, by writers of standing. Two short papers on the share which Europe means to have in the Fair at Chicago next year, written by our Consuls-General at Berlin and St. Petersburg, will find many readers.

The leading article in the POPULAR SCIENCE MONTHLY for December is a continuation of Dr. Andrew D. White's series on the Warfare of Science. The title of this one is From Magic to Chemistry and Physics, which will indicate its subject. Deafness and the Care of the Ears is treated by Dr. A. M. Fanning, and Arthur Kitson writes of the Fallacies of Modern Economists. Some shorter articles make up a very interesting number.

The October number of GOOD ROADS has a number of excellent articles and is well worth attention.

With the November number the ARENA closed its sixth volume. In its three years of life this magazine has made a place for itself, and has gained the respect of the reading and thinking public. It is strong and aggressive, speaking without hesitation on subjects of the highest public interest, and it has always something to give the reader which will claim his careful consideration.

The first number of the new volume shows no decrease in interest and presents an excellent table of contents.

A recent addition to the list of technical journals is TRANSPORT, a weekly published in London. A large part of its space is devoted to harbors, canals and water-ways, but it has also something to say about railroads and ship-building. The articles are generally short; but the numbers before us manage to give a great deal of information in a condensed form.

The October number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE has, besides a continuation of the Columbus articles, papers on Social Life in China; the Wind as an Erosive Agency; the North Carolina Coast; Movements of the Earth's Crust; Origin and Diffusion of Cholera; besides several others of general interest. This magazine always has a number of articles which will interest the reader, besides those of special geographical value.

In the number of HARPER'S WEEKLY for November 2 the opening ceremonies of the Chicago Exposition are described and illustrated. The same number also has an illustrated description of the City of Mexico. The number for November 7 continues the Exposition illustrations, and has also illustrated papers on the Milwaukee Fire, on the Chicago Lake Front, and on Christiania, the capital of Norway. An article on Electric Railroads gives some interesting statistics.

The December number of SCRIBNER'S MAGAZINE is the holiday number, and is notable for the number of short stories and the excellent illustrations. More solid matter is not lacking, however, and there are articles on Norwegian and French Painters, on the German Entry into Paris, and on the Chicago Exposition Buildings, which are just now a central point of interest.

In the OVERLAND MONTHLY for November a second paper on the University of California is timely, as it gives a careful account of the observatory and its management, which has recently been the subject of much criticism; some excellent illustrations accompany this paper. An illustrated description of the Santa Lucia Mountains in Monterey County treats of a part of California as yet but little known. The Fisheries of California are discussed by Professor David Starr Jordan, and a short but interesting article describes the Siwash Indians of Puget Sound, a peculiar people.

The December number of HARPER'S MAGAZINE is a Christmas number, and is largely given up to short stories and illustrations; some of the latter are very fine specimens of the engraver's art. This number opens the 86th volume of this magazine.

The November number of OUTING is bright and seasonable, and the illustrations are of excellent quality. Among the articles in this number are Yumi, the Japanese Long-bow, by Robert G. Denig; Through Darkest America (continued), by Trumbull White; Battles of the Football Season of '91, by Walter Camp; Bicycle Riding in Germany, by Fanny B. Workman; A Day with the Quail, by Ed. W. Sandys; A Thanksgiving Day's Bear-Hunt, by H. S. Habersham; A Moot Point in Track Athletics, by John Corbin; National Guard of New Jersey (second paper), by Lieutenant W. H. C. Bowen, U. S. A.; Round the World with Wheel and Camera (continued), by Frank G. Lenz; Sturgeon Fishing in Russia, by Robert F. Walsh; and the usual editorials, poems, records, etc.

In the ECLECTIC MAGAZINE for November there are some excellent articles, including New Japan, from the *Fortnightly Review;* Storage of the Nile Flood, from *Blackwood's Magazine;* Growth of Industrial Peace, from the *Contemporary Review;* Where did Columbus First Land? from the *Nineteenth Century;* and a good selection of minor articles from the English periodicals.

In the November number of the ENGINEERING MAGAZINE there are articles on Light in Tall Office Buildings; Industrial Development of the South; Progress in Wood Working; City Hall Architecture in America; the Geological Survey; What Engineering Owes to Chemistry; Relative Cost of Gas and Electricity; the Mississippi Problem; the Electric Motor and the Farmer; Business Opportunities in Cuba; and the usual special departments. The number is well illustrated.

BOOKS RECEIVED.

Our Share in Coast Defense. Part I.: the 12-inch Breech-loading Rifled Mortars. Providence, R. I; the Builders' Iron Foundry. Some extracts from this pamphlet will be found on another page.

First Report of the Bureau of Mines of the Province of Ontario, 1891. Toronto, Ont.; published by order of the Legislative Assembly.

Modern Locomotive Construction. By J. G. A. Meyer. Cloth, 1,030 illustrations. Price, $10. New York; John Wiley & Sons.

Annals of the Italian Society of Engineers and Architects: Number IV, Volume VII, August, 1892. Rome, Italy; published by the Society.

Transactions of the Canadian Society of Civil Engineers: Volume VI, Part I: January–June, 1892. Montreal; published by the Society.

Transactions of the Technical Society of the Pacific Coast: October, 1892. San Francisco; published by the Society.

Proceedings of the Fifth Annual Convention of the Train Dispatchers' Association of America; held at New Orleans, La., June 14–17, 1892. J. F. Mackie, Editor. Published by the Association.

Proceedings of the Engineers' Club of Philadelphia: Volume IX, No. 4; October, 1892. Philadelphia; published by the Club.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, relative to the Imports, Exports, Immigration and Navigation of the United States for the Quarter ending June 30, 1892. Hon. S. G. Brock, Chief of Bureau. Washington; Government Printing Office.

Transactions of the American Institute of Electrical Engineers: Volume IX, Nos. 7 *and* 8; *July and August,* 1892. This number contains the papers read at the general meeting in Chicago in June last.

TRADE CATALOGUES.

ALL subscribers who are interested in history should take advantage of the offer made on another page by Mr. A. O. Norton, of Boston, to send them an engraving of the Original Jack carried on board the *Ark* by Captain Noah. We have been favored with an advance copy, and must say that from internal evidence we believe that it is an excellent and faithful representation. It is accompanied by some engravings of jacks of later date.

Inventive Progress. Benefits of the American Patent System. William A. Rosenbaum, New York.

This handsome pamphlet contains some general remarks on the patent system, the nature of patents and the kind of inventions which are patentable. It is illustrated by views of the Patent Office and portraits of a number of noted inventors.

Illustrated Catalogue of Machinists' Tools. F. E. Reed & Company, Worcester, Mass.

This catalogue illustrates and describes a great variety of lathes of different sizes and also several patterns of milling machines. Most of these are of forms well approved by use, but improvements are not by any means excluded.

The Heating of Railroad Shops. The Huyett & Smith Manufacturing Company, Detroit, Mich.

This little pamphlet contains illustrations of the Smith hot-blast apparatus, with views and plans of several large shops heated by this device. The hot-air system has many features to recommend it, and it can often be applied where no other plan can well be adopted. For shops with a large open area it seems especially well fitted.

Some Facts of Interest in Regard to Sargent's Automatic Smoke Preventer. Sargent & Greenleaf, Rochester, N. Y.

This pamphlet describes and illustrates Mr. James Sargent's device for burning bituminous coal; giving also some records of tests and experiences had with it. The prevention of smoke from bituminous coal has been the object of many inventions, and this one seems to have attained a very fair degree of success.

1. *List of Gearing.* 2. *Illustrated Catalogue of Turbine Water Wheels.* 3. *Shafting, Pulleys and Hangers. The Robert Poole & Son Company, Baltimore, Md.*

These catalogues show a great variety of work. The especial department in which the company named does the largest work is machinery for the transmission of power, as indicated by the catalogues named. This does not cover all its work, however, for a large amount is done in its shops on cable railroad plants and on special machinery of the heaviest class.

Cylinder Lubricators, Grease-cups, etc. Catalogue No. 2. *The Lackawanna Lubricating Company, Scranton, Pa.*

This catalogue contains well-illustrated descriptions of the cylinder lubricators and other devices made by the company named, which is comparatively new, but is building up a considerable business by excellence of work and careful attention to details.

The United States Metallic Packing Company. Philadelphia, Pa.

This very neatly printed and bound book contains illustrated descriptions of the various kinds of packing made by this company for locomotives, stationary and marine engines. This packing is well known and widely used; and the company's book gives the strongest possible certificate to its excellence in the shape of a list of users which occupies a number of closely printed pages. It includes railroads, manufacturers and engine-builders in all parts of the world, showing how far this packing has made its way.

General Illustrated Catalogue, No. 27. *The Huyett & Smith Manufacturing Company, Detroit, Mich.*

This handsomely illustrated pamphlet contains descriptions of a great variety of apparatus made by the company named. These include dry-kilns, brick dryers, hot-blast apparatus, ventilating fans, blowers for various purposes, engines, marine water-tube boilers, dust separators, cotton fans, exhaust fans, steam traps, blast gates, etc.—a pretty comprehensive list. After a study of this catalogue one can appreciate better than ever before the variety of purposes to which the fan blower can be applied.

Approved Elevating and Conveying Apparatus. The Link-belt Machinery Company, Chicago.

This handsome catalogue gives descriptions and illustrations of several kinds of link-belting and their application to different purposes. The link-belt has been introduced in so many places and has served the purposes for which it was devised so well, that it is now generally known, and any description here would be superfluous. For elevators and for conveying machinery generally it seems to be replacing the old appliances wherever it becomes known.

The Link-Belt Company does a large business in machinery for the transmission of power, as well as for elevating purposes; and some reference to this will also be found in the catalogue.

Price List of Supply and Repair Parts, Electric Railroad Apparatus. October, 1892. *The General Electric Company, New York.*

The General Electric Company. Bulletin No. 1,003: *Railroad Power Generators. Bulletin No.* 1,004: *W. P. Railroad Motors. Issued by the Company.*

SOME CURRENT NOTES.

THE Russian Trans-Caspian Railroad, it is announced, will be extended from its present terminus at Samarcand northeast about 200 miles to Tashkend, an ancient city and the commercial center of Eastern Turkestan. The building of this extension will take about two years and will be under the charge of General Annenkoff, who was the engineer of the older portion of the line.

A further extension is under consideration, from Tashkend to Khokand, about 150 miles. It is probable that construction work will be continuous until the road reaches the eastern frontier of China.

THE deepest well in Europe is an experimental boring made at Schladebach, Germany, in the prosecution of some geological researches. This boring has reached a depth of 5,717 ft., over a mile, but the results so far obtained have not been important.

THE next international exposition after Chicago's is to be held in Antwerp in 1894. Preparations have already been begun, and a site has been chosen for the buildings. This will take the place of the exposition which it had been proposed to hold in Brussels in 1895. It is possible, however, that the date of the Antwerp exposition may be changed to 1895.

THE railroad line from Jaffa to Jerusalem, which has been lately opened for business, is 54 miles in length. At present the journey takes three hours, but when the road is fully in order and the road-bed settled a decrease in time to two hours will be made.

The company has the concession for several lines and work has already been begun on two branches. The first starts from the main line at Ramleh and will be built this year to Naplouse, 31 miles; this road is the beginning of a line to Damascus and Upper Syria. The second branch also starts from Ramleh and is to run to Gaza, about 47 miles; from Gaza it will be extended hereafter to El Arich on the frontier of Egypt.

A NEW use for aluminum has been found by a French inventor, who places a very thin plate of the metal between the two thicknesses of leather in the sole of a shoe. If the plate is made thin enough it will not make the sole too stiff; the metal will keep out moisture and will add to the warmth of the foot.

IT is stated by Herr Reinhardt Mannesmann that the addition of a small percentage of tungsten to aluminum increases its tensile strength to a remarkable degree. This tungsten-aluminum alloy also possesses the quality of resistance to the effects of water alone, of salt water and of impure water, showing no signs of oxidization even after long submersion.

A NEW oil field has been discovered in Sumatra, and from test borings it is thought that oil will be found over some 400 square miles of country. Wells already bored at Langkat are yielding from 3,000 to 4,000 barrels a month. The oil is reported as much better than that from the Baku wells in Russia and equal to good Pennsylvania oil. The oil district lies on the coast, where shipments are easily made. The Dutch colonial authorities have granted many concessions for wells.

SOME trials have been made on the Metropolitan Railway, in London, of Anderson's system of ventilation. A rectangular tube is laid between the rails. This has valves on top, which are opened by the locomotive as it passes. At intervals on the line are stations where exhaust fans draw out the smoke, gas, etc., from the ventilating pipe and discharge it through a chimney into the outer air. On the section fitted with this apparatus it has worked well enough to encourage the company to make further trials.

THE Waddell-Entz storage battery is to be tried on the Second Avenue Railroad, in New York. The batteries will be placed under the seats, each car carrying 100 cells, weighing 2,700 lbs. in all. A modified type of the Gramme hollow ring motor will be used, one placed on each axle.

AN artesian well has been sunk at Galveston, Tex., to the depth of 3,071 ft. without obtaining water. The pipe sunk is 22 in. for 57 ft.; then 15 in to a depth of 870 ft.; 12 in. to 1,500 ft.; 9 in. to 2,363 ft., and 6 in. to the lowest point reached. The borings showed in succession 46 ft. of gray sand; 18 ft. of red clay and shells; 36 ft. of blue clay mixed with shells and fragments of rotten wood; 218 ft. of sand, shells and wood; 497 ft. of sandy clay; 473 ft. of clay mixed with sand, shells and rotten wood, and below that strata of sand and clay with some large logs. At the bottom the drill struck a bed of shells.

The city of Galveston has a number of artesian wells from 825 to 1,350 ft., but the water is unfit for domestic purposes, though it is used in boilers, etc. The experiment just made cost the city $75,000.

THE new cruisers *Raleigh* and *Cincinnati* have about the same displacement and armament as the "M" class of cruisers of the British Navy, the *Davoust* of the French Navy and the Italian *Giovanni Bausan*. The "M" cruisers have been very unfortunate, having had many accidents, due chiefly to defects in design. The boilers and machinery were too light, and some structural weakness was developed also. The general opinion has been that strength was sacrificed to secure speed. This mistake, it is believed, has been avoided in our own ships.

A NEW freight engine, lately completed at the Crewe shops of the London & Northwestern Railway, has 20 × 24-in. cylinders and four 51-in. wheels all coupled. She has a long boiler with two sets of tubes and combustion chamber in the center of the barrel, similar to that of the *Greater Britain*, which was illustrated in the JOURNAL a short time ago.

THE sum of $5,000 has been given by the Emperor of Germany to build a balloon for military purposes, and $2,000 more for conducting experiments. The balloon will be 56 ft. in diameter, and will hold about 90,000 cub. ft. of gas. It will be used, if successful, in military reconnoisances and in taking scientific observations.

THE south jetty, or breakwater at the mouth of Galveston Harbor, is now completed for 24,600 ft. from the shore. It is built of large stones carefully selected and piled up. Work on the north jetty has just been begun.

It is found that these jetties are already beginning to have a remarkable effect on the channel, the sand at the bottom being scoured out by the force of the currents.

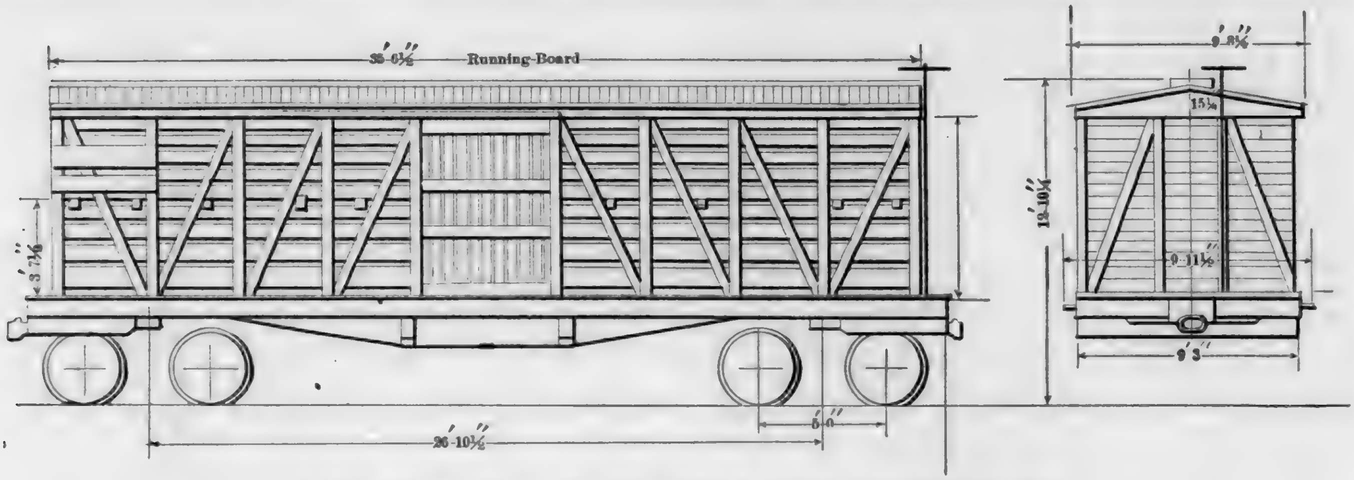
FROM recent data furnished by the surveying parties in the field, the Intercontinental Railroad Commission reports that the construction of a railroad from a port on the Caribbean Sea through Colombia, Ecuador and Peru to Lake Titicaca, on the western border of Bolivia, is entirely practicable. The distance is 2,800 miles, and the line traverses in part the great Andine plateau, the ascent to which can be made by works of moderate cost. The country has great natural resources as yet only partially developed.

The parties in Central America have nearly completed the preliminary lines through Nicaragua and San Salvador, and are now at work in Costa Rica.

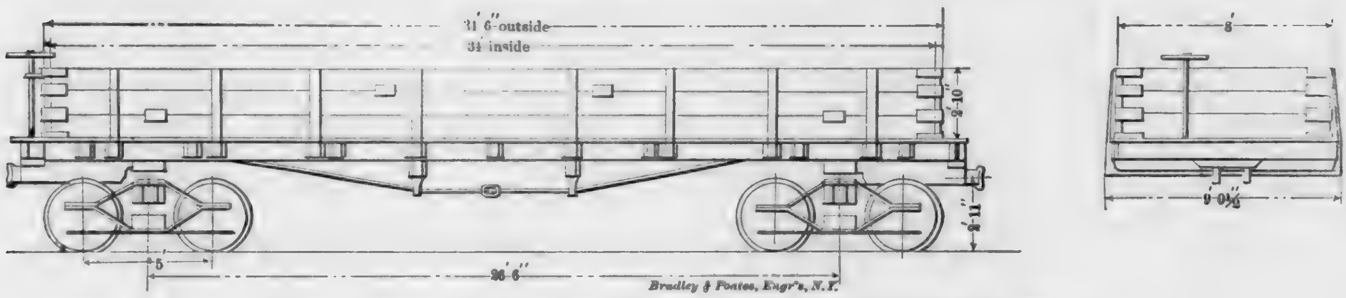
SOME recent experiments made in Austria seem to show that mild steel cooled to a temperature of 100° below zero opposes quite as much resistance to bending and fracture as at ordinary temperatures. The tests were made with small bars under a falling weight, and in every case the bending and permanent set were less with the cooled bars.

A LARGELY signed petition to Congress for the establishment of a Bureau of Roads is to be presented at the next session. The petition is being widely circulated, and has already received many signatures. The maintenance of an Institute of Road Engineering for popular instruction in this question is also proposed, as well as a permanent exhibition of road material and machinery.

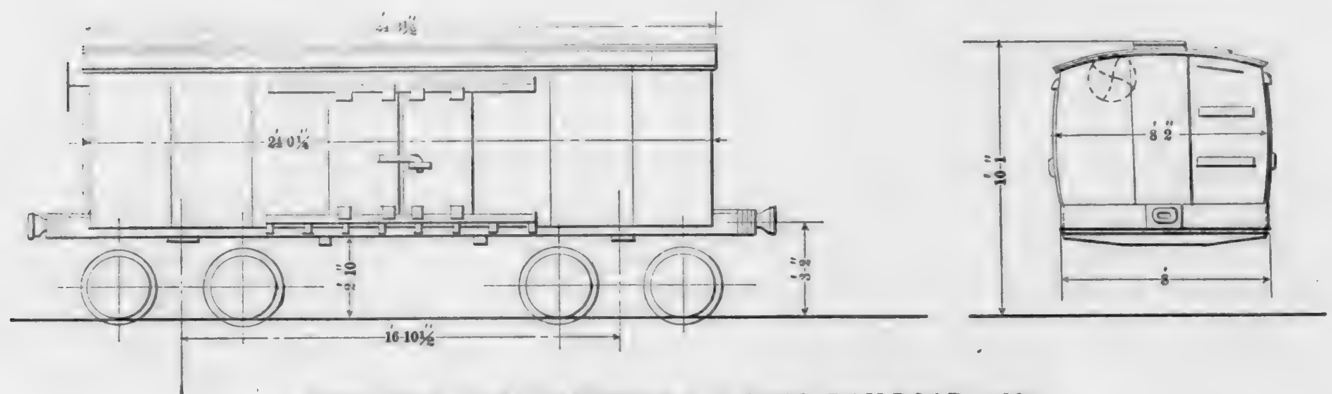
THE Rapid Transit Commission in New York has so far completed its work that the franchise for the underground lines which it laid out is advertised for sale. The sale will take place January 29, and the purchaser will have to give security for the commencement of work within a given time, and its completion within a reasonable limit. A company must be organized with $50,000,000 capital. The sale will be made to the party giving the proper security who will offer the city the best terms for the franchise.



34 FT. STOCK CAR, BALTIMORE & OHIO RAILROAD—1886.



34-FT. GONDOLA CAR, BALTIMORE & OHIO RAILROAD—1890.



IRON BOX CAR; BALTIMORE & OHIO RAILROAD—1862.

THE Nicaragua Canal Convention, which met in St. Louis in June last, was called to reassemble in New Orleans, November 30. The object of the second meeting was to take measures to present to Congress the claims of the Canal for assistance and endorsement.

AT the request of a number of manufacturers, a test of the comparative strength and holding power of cut nails and of steel wire nails was begun on the testing machine at the United States Arsenal, Watertown, Mass., on November 30. The tests are conducted by a committee of manufacturers, and will include all the sizes ordinarily in use. In view of the great extent of the nail manufacture and the sharp competition now existing between the two kinds of nails, these tests are of considerable importance.

THE production of iron, which had been gradually decreasing for some months, has taken a turn and is now increasing. The *American Manufacturer's* report shows that on November 1 there were in blast 258 furnaces with a productive capacity of 173,925 tons per week; an increase in capacity of 12,367 tons during October.

The capacity of the blast furnaces at work, however, is considerably less than it was a year ago. As compared with November, 1891, the report shows a decrease of 18,818 tons, or 9.7 per cent., in the weekly output. The greatest degree of activity at present is found in Ohio and in the South.

A VERY remarkable run was made by the Empire State Express on the New York Central & Hudson River Railroad east over the Mohawk Division of that road on on November 8. The train left Syracuse 30 minutes late and arrived at Albany only 10 minutes late, having made the run of 147½ miles in 2 hours 35 minutes, including a stop of 3 minutes at Utica. It consisted, as usual, of four cars, and was drawn by Engine No. 893. The average speed, including stops, was thus 57.10 miles an hour.

The run from Syracuse tunnel to Utica station, 51.67 miles, was made in 46 minutes, or at an average speed of 67.38 miles an hour. The distance from Chittenango to Schenectady, 116.16 miles, was covered in 110 minutes, or at an average speed of 63.36 miles an hour. This is a remarkable instance of long-sustained high speed.

THE Pennsylvania Railroad has recently begun the work of doing away with one of the most troublesome grade crossings in the country—that where its tracks now cross those of the New Jersey Central at Elizabeth, N. J. To do this requires the raising of the tracks for nearly two

miles. There are four tracks, and the first work to be done is to raise two of them to the required grade on a temporary wooden trestle. When this is done, the permanent road-bed for the other two tracks will be built, and lastly the trestle first built will be replaced. Wherever possible the new road-bed will consist of earth embankment with masonry retaining walls; some of the city streets will be crossed by arch bridges of masonry and others by iron bridges. The New Jersey Central tracks will be spanned by an iron bridge.

The cost and difficulty of the work is increased by the fact that it must be done without stopping or delaying the traffic of the road. The importance of the change is shown by the fact that a recent count showed trains passing over the crossing at an average of less than three minutes' interval during the busy part of the day; and, although no serious accident has ever occurred at the crossing, it is a constant source of delay and danger to both roads.

A PECULIAR method of burning bricks is practised by the natives of Western Mongolia and the Pamir in Central Asia, which produces a brick of great hardness and not affected by the extreme changes of temperature to which those regions are subject. The great point in the process seems to be the use of a supply of water which is allowed to pass into the closed kilns, producing a volume of steam which permeates every part of the pile of bricks and seems to produce a molecular change in their structure. The bricks produced are usually somewhat larger than our customary size; they are very hard, sonorous, broken with difficulty, and present an appearance not very different from that of some of the trachytic rocks. The process seems to have some industrial value.

SOME experiments have recently been made in the electric lighting of cars on the Western Railroad of France which have thus far given encouraging results, although they have not been continued long enough to make a final decision. In these the electric current is furnished by a group of batteries of the Merrittens type—a modification of the Smee battery—carried in a box under the car floor. The lamps used are eight candle-power, and the batteries carried on each car will light it for 48 hours without renewal. As to cost, the trial so far shows a result of 1.4 cents per lamp-hour. The electric light is thus considerably more expensive than oil or gas. The experiments are to be continued.

SOME BALTIMORE & OHIO CARS.

THE drawings given with this article show three patterns of cars used on the Baltimore & Ohio Railroad, two of them being standards of the present day, while the third may be considered rather as a historical relic.

The first is the standard stock car at present in use, and its general construction is sufficiently well shown in the drawing. This car is 34 ft. long inside, 8 ft. 7 in. wide and 7 ft. 6 in. high; its outside width over all is 9 ft. 11½ in., and the frame is 36 ft. 6½ in. long over the end sills. The trucks are of the standard pattern and have 33-in. wheels. The door has a clear opening of 5 ft. and a height of 7 ft. The weight of a car of this pattern is 30,700 lbs., and its carrying capacity is rated at 40,000 lbs.

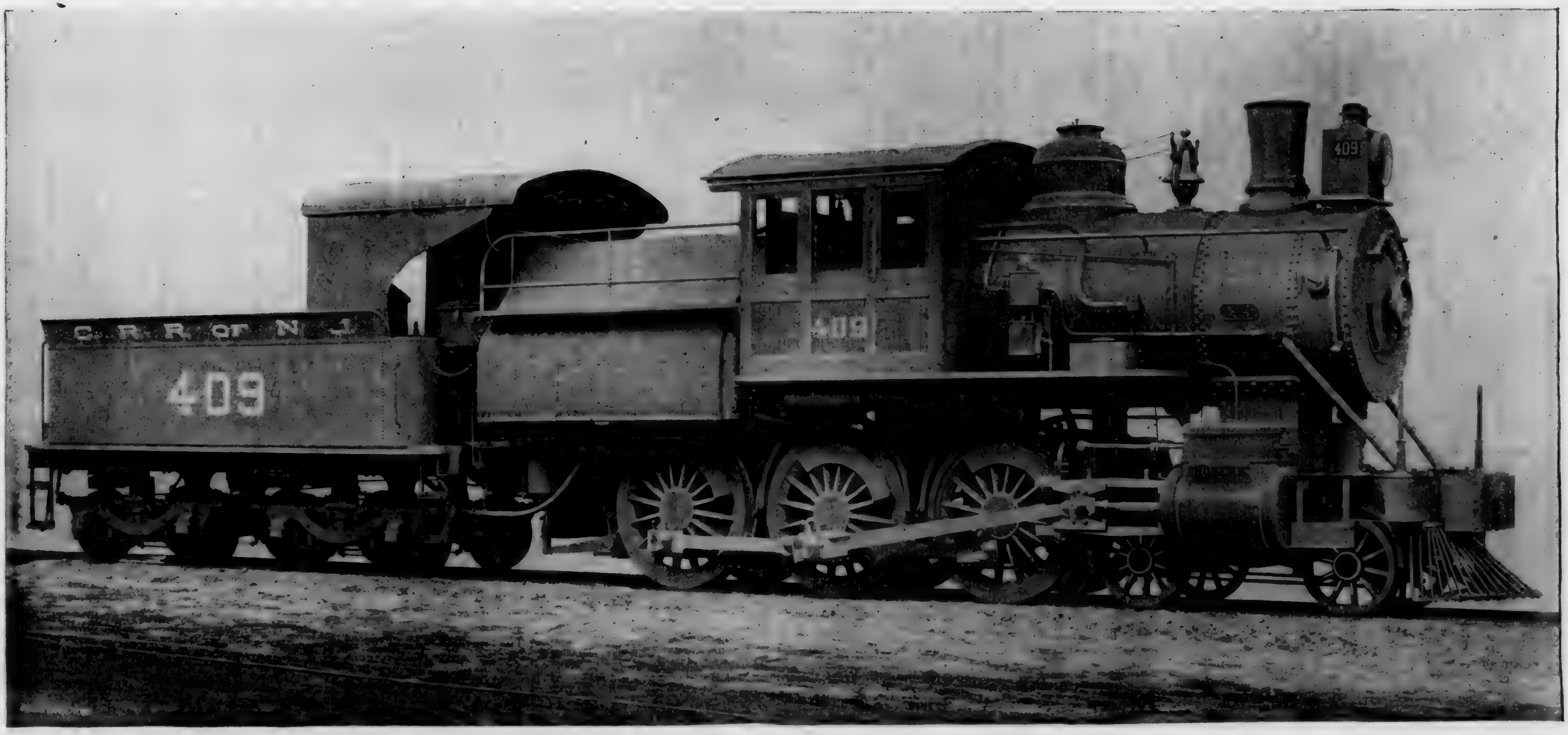
The second car is the present standard pattern of gondola, having a length of 34 ft. and a width of 7 ft. 6 in. inside the side-boards. The length over end sills is 36 ft. 6 in., and the extreme width 9 ft. 0½ in. The ordinary siding is 2 ft. 10 in. above the floor. The trucks are of the standard pattern and have 33-in. wheels. The weight of this car empty is 24,850 lbs., and it is rated at 60,000 lbs. capacity. Like the car first referred to, this is a good example of modern practice on the road.

The third illustration shows an iron box car of a type first built some 30 years ago, which was, we believe, peculiar to this road; at least we cannot recall a similar pattern on any other line. The siding and roof of this car were of iron, the only wood about it being in the floor and floor framing. Like most box cars of the same date, it was smaller than the present standard cars, having a clear inside length of 23 ft. 8 in., width 7 ft. 6 in. and height 6 ft. 1 in. The doors were small, having a clear opening 4 ft. 10½ in. wide and 5 ft. high. The sides were not straight, but wider in the center than at floor or roof, as shown in the end view. The extreme length over the drawheads was 28 ft. 7½ in., and the extreme width 8 ft. 10 in. The trucks were spaced 16 ft. 10½ in. between centers, and the wheels are 31 in. in diameter. The weight of this car was 18,000 lbs.; its capacity is not stated, but could hardly be as much as 30,000 lbs. Those who saw these cars on the Baltimore & Ohio during the war know that they seemed to stand very hard service well, but their building was not continued, for some reason not stated. It may have been their first cost, or very possibly because they were more difficult to repair after an accident than the ordinary wooden car. At any rate, this iron car is an interesting type, and certainly has some good points.

COMPOUND LOCOMOTIVE TESTS.

IN reply to some remarks made in the November number of the JOURNAL on the tests of compound locomotives on the Mexican Central Railroad, an account of which was then published, Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery of that road, writes as follows:

In reply to your inquiries will say that these six bogie engines entered service during the months of September, October and November, 1890; therefore during the months from which the test was taken the engines were only a year old, and as the tubes run for four or five years on this division, and an engine remains out on the road for two years or more between overhaulings, you will see that these engines were in good condition and cannot be classed as old engines. In fact, they were in better condition than when they first entered service. On the other hand, the compound engines were more or less an experiment, and I was continually making slight changes and modifications upon them, which expense they had to bear. These bogie engines have a continuous frame carrying the boiler and tender, and the engine in working order with tank of fuel and water weighs 96 tons by actual weight on track scales. The engine has a pony truck with 17,000 lbs. on the truck. The compounds in working order, with tender loaded with fuel and water, weigh 97 tons, the engine having a four-wheel truck with 29,300 lbs. on the truck. Our experience with these compounds lead us to believe that in their present perfected condition they will continue from now on to run at less expense for repairs than the high-pressure engines doing the same work. In looking up the cause of the compound doing more work with less mileage than the bogie engines, I find that where the bogies have been obliged to double the hills, the compounds have been thrown into high pressure and have taken their trains over these hard places, and therefore have kept down their mileage in doing a given amount of work. This is an advantage decidedly in favor of the compound system. On this division where the compounds are running, we have a wooding station nine kilos from the top of the hill. Wood cars are loaded at this point, and conductors have orders to keep the side track clear of cars when loaded. If a high-pressure engine arrives at this station with a good train, and is obliged to take six or seven wood cars, they are compelled to double these nine kilos, while the compound is simply thrown into high pressure and the sand ejectors put to work. Under these conditions the hauling capacity of the engine is increased about 40 per cent., and we consider it more economical to run these nine kilos in high pressure than to double the hill. Again, nearer Mexico we have a piece of 1¼ per cent. grade three kilos long, not compensated for curvature. As this is a short hill, conductors have orders to fill out their trains along the level country before reaching the hill, and are expected to double the hill if necessary. This is another place where the compounds are thrown into high pressure, and time and locomotive mileage is saved. With these facts in view, I think the compounds should get credit for the full value of the figures shown in their performance.



TEN-WHEEL LOCOMOTIVE WITH WOOTTEN BOILER,

FOR THE CENTRAL RAILROAD OF NEW JERSEY.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

COLUMBIAN EXPOSITION NOTES.

THE Bureau of Hygiene and Sanitation, under the direction of Dr. F. W. Brewer, has recently issued an interesting circular, the substance of which is given below.

Starting from the standpoint that "the common health is the common wealth" and that hitherto sanitation and sanitary science have not received that amount of general public support which their importance demands, the Bureau will seek to set before the visitors to the Exposition such a representation of sanitary work and sanitary aids as will help to lift the general mind to a higher plane in its estimate of the work of sanitation. Not even the most exaggerative optimist would assert that the sanitary arrangements of our chief and best-cared-for cities are perfect, while it is well known that those of smaller towns and villages are of the most reprehensible type. On the other hand, the pessimist cannot deny that the last two decades have seen very great and very marked improvements in the theory of hygiene as a science and in its practice as an art; the "vantage ground" thus gained, it is to be hoped, will be but a new base from which a more general and complete advance all along the line may be made. That eminent sanitary pioneer, Edwin Chadwick, dared to predict that the realization of municipal and domestic sanitary reforms would eventually result in the establishment of a death-rate of five to seven per thousand in hygeian districts; thus every improvement of sanitary measures will be an aid to the fulfillment of Chadwick's vision. The often-quoted but never-to-be-forgotten results of sanitation in the city of Munich is an apt illustration of the benefits derivable. When that city was devoid of sewerage and pure water supply the death-rate from typhoid fever—pre-eminently a disease reveling in filth—was 24.20 per ten thousand. The illustrious scientist, Pettenkofer, was consulted, and recommended the establishment of a system of sewerage and the introduction of a water supply from a new source. Upon the inauguration of the new systems the death-rate was reduced to 13.30 per ten thousand; partial progress further reduced it to 9.26 and the completion of the cloacinæ caused the rate finally to fall to 1.75 per ten thousand, at which it has approximately remained.

While much in front of most other countries, the United States, with a death-rate to-day of 18 per thousand, has an arduous advance to make, but it is confidently anticipated that among the many brilliant achievements of the World's Columbian Exposition that of advancing the work of sanitary reforms will not be the least.

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A HEAVY TEN-WHEEL LOCOMOTIVE.

THE large engraving on the opposite page is from a photograph of one of a number of engines built by the Rogers Locomotive Works, in Paterson, N. J., for the Central Railroad of New Jersey, and now in service on that road. These engines are of the largest class, and are adapted for working very heavy trains. They are, as shown, of the ten-wheel type, having six driving-wheels and a four-wheel truck.

The boiler is of the Wootten pattern, and is of steel, $\frac{9}{16}$-in. plates being used for the outside shell. The barrel is 66 in. in diameter, and has 258 tubes 2 in. in diameter and 10 ft. 10 in. long. The fire-box is of steel, and is 9 ft. 6 in. long inside, 8 ft. $0\frac{3}{8}$ in. wide and 4 ft. $1\frac{3}{4}$ in. deep; the combustion chamber is 4 ft. $1\frac{1}{4}$ in. long. The grate area is 76 sq. ft.; the heating surface is: Fire-box, 146; combustion chamber, 63; tubes, 1,451; total, 1,660 sq. ft.

The cylinders are 21 in. in diameter and 26 in. stroke. The steam-ports are $1\frac{1}{2} \times 20$ in., and the exhaust-ports $3\frac{1}{4} \times 20$ in., the bridges being $1\frac{1}{4}$ in. The valves are of the Richardson balanced pattern, and have $\frac{7}{8}$ in. outside lap and no inside lap. The maximum travel is $5\frac{1}{2}$ in. and the lead is 0.1 in. in full gear.

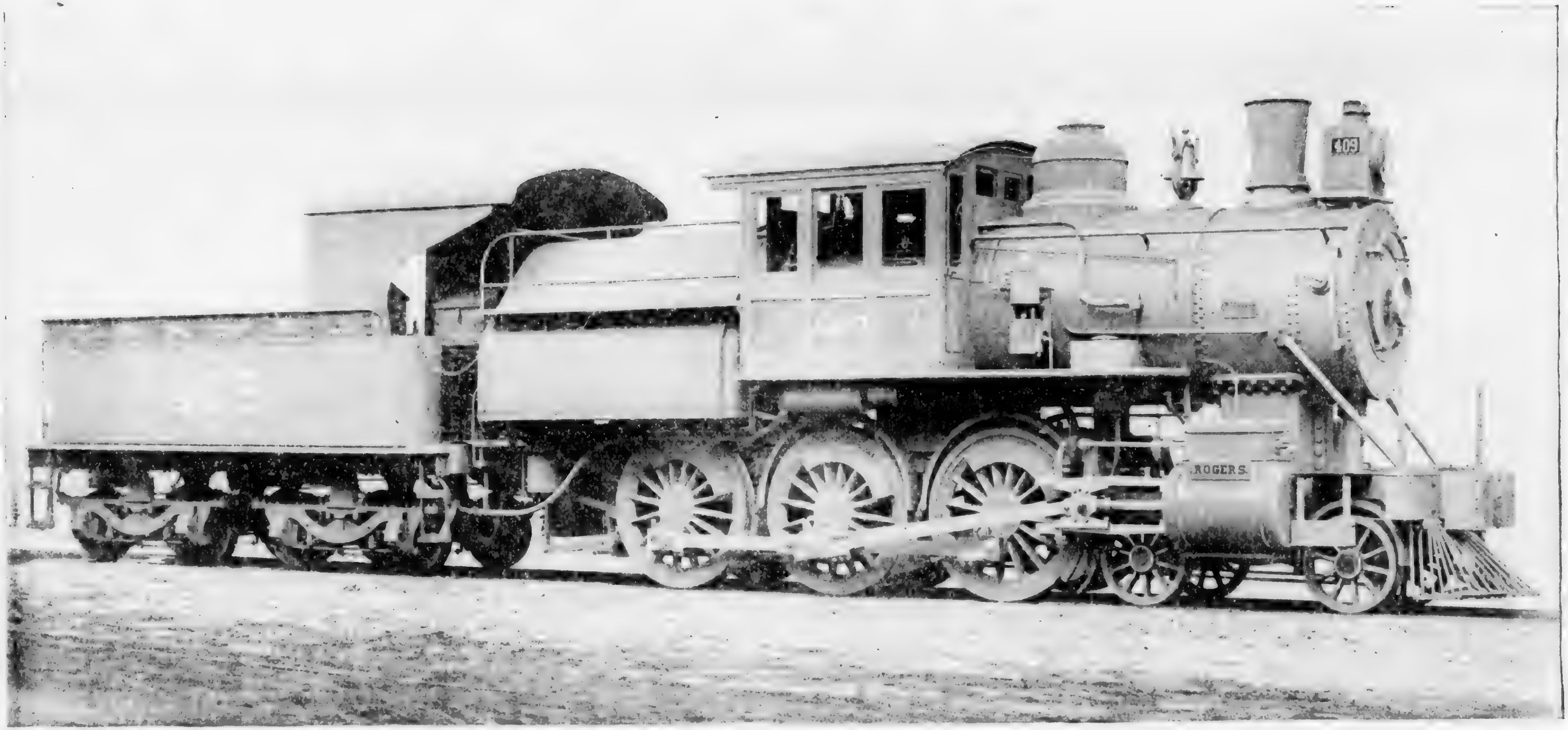
The driving-wheel-base is 12 ft. and the total wheel-base 22 ft. 11 in. The driving-wheels are 63 in. in diameter. The tires are 3 in. thick, those of the main and rear pair being flanged and $5\frac{3}{4}$ in. wide; those of the forward pair are plain and are $6\frac{1}{2}$ in. wide. The driving-axles are of hammered iron, and have journals 8 in. in diameter and $10\frac{1}{2}$ in. long.

The four-wheeled truck is of the rigid-center pattern. The axles are of iron with journals 5 in. in diameter and 10 in. long. The truck wheels are 33 in. in diameter, and are solid steel spoke wheels made by the American Steel Wheel Company.

The engine is fitted with the Westinghouse automatic air brake on the tender and the American Brake Company's outside equalized brake on the drivers. There are two No. 10 standard Metropolitan injectors with Nathan checks and starting valves. Metallic packing is used on the piston-rods and valve-stems.

The total weight of this engine in working order is 146,500 lbs., of which 31,000 lbs. are carried on the truck and 115,500 lbs. on the drivers; an average of 19,250 lbs. per wheel.

The tender frame is of 9-in. channel iron. The tank is of steel and will hold 3,600 galls. of water. The tender is carried on two four-wheel trucks. The axles are of hammered iron, and have journals 5 in. in diameter and 8 in. long. The wheels are 33 in. in diameter, and are of the



TEN-WHEEL LOCOMOTIVE WITH WOOTTEN BOILER,

FOR THE CENTRAL RAILROAD OF NEW JERSEY.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

COLUMBIAN EXPOSITION NOTES.

THE Bureau of Hygiene and Sanitation, under the direction of Dr. F. W. Brewer, has recently issued an interesting circular, the substance of which is given below.

Starting from the standpoint that "the common health is the common wealth" and that hitherto sanitation and sanitary science have not received that amount of general public support which their importance demands, the Bureau will seek to set before the visitors to the Exposition such a representation of sanitary work and sanitary aids as will help to lift the general mind to a higher plane in its estimate of the work of sanitation. Not even the most exaggerative optimist would assert that the sanitary arrangements of our chief and best-cared-for cities are perfect, while it is well known that those of smaller towns and villages are of the most reprehensible type. On the other hand, the pessimist cannot deny that the last two decades have seen very great and very marked improvements in the theory of hygiene as a science and in its practice as an art; the "vantage ground" thus gained, it is to be hoped, will be but a new base from which a more general and complete advance all along the line may be made. That eminent sanitary pioneer, Edwin Chadwick, dared to predict that the realization of municipal and domestic sanitary reforms would eventually result in the establishment of a death-rate of five to seven per thousand in hygeian districts; thus every improvement of sanitary measures will be an aid to the fulfillment of Chadwick's vision. The often-quoted but never-to-be-forgotten results of sanitation in the city of Munich is an apt illustration of the benefits derivable. When that city was devoid of sewerage and pure water supply the death-rate from typhoid fever—pre-eminently a disease reveling in filth—was 24.20 per ten thousand. The illustrious scientist, Pettenkofer, was consulted, and recommended the establishment of a system of sewerage and the introduction of a water supply from a new source. Upon the inauguration of the new systems the death-rate was reduced to 13.30 per ten thousand; partial progress further reduced it to 9.26 and the completion of the cloacinæ caused the rate finally to fall to 1.75 per ten thousand, at which it has approximately remained.

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A HEAVY TEN-WHEEL LOCOMOTIVE.

THE large engraving on the opposite page is from a photograph of one of a number of engines built by the Rogers Locomotive Works, in Paterson, N. J., for the Central Railroad of New Jersey, and now in service on that road. These engines are of the largest class, and are adapted for working very heavy trains. They are, as shown, of the ten-wheel type, having six driving-wheels and a four-wheel truck.

The boiler is of the Wootten pattern, and is of steel, $\frac{9}{16}$-in. plates being used for the outside shell. The barrel is 66 in. in diameter, and has 258 tubes 2 in. in diameter and 10 ft. 10 in. long. The fire-box is of steel, and is 9 ft. 6 in. long inside, 8 ft. $0\frac{3}{8}$ in. wide and 4 ft. $1\frac{3}{4}$ in. deep; the combustion chamber is 4 ft. $1\frac{3}{4}$ in. long. The grate area is 76 sq. ft.; the heating surface is: Fire-box, 146; combustion chamber, 63; tubes, 1,451; total, 1,660 sq. ft.

The cylinders are 21 in. in diameter and 26 in. stroke. The steam-ports are $1\frac{1}{2} \times 20$ in., and the exhaust-ports $3\frac{1}{4} \times 20$ in., the bridges being $1\frac{1}{4}$ in. The valves are of the Richardson balanced pattern, and have $\frac{7}{8}$ in. outside lap and no inside lap. The maximum travel is $5\frac{1}{2}$ in. and the lead is 0.1 in. in full gear.

The driving-wheel-base is 12 ft. and the total wheel-base 22 ft. 11 in. The driving-wheels are 63 in. in diameter. The tires are 3 in. thick, those of the main and rear pair being flanged and $5\frac{3}{4}$ in. wide; those of the forward pair are plain and are $6\frac{1}{2}$ in. wide. The driving-axles are of hammered iron, and have journals 8 in. in diameter and $10\frac{1}{2}$ in. long.

The four-wheeled truck is of the rigid-center pattern. The axles are of iron with journals 5 in. in diameter and 10 in. long. The truck wheels are 33 in. in diameter, and are solid steel spoke wheels made by the American Steel Wheel Company.

The engine is fitted with the Westinghouse automatic air brake on the tender and the American Brake Company's outside equalized brake on the drivers. There are two No. 10 standard Metropolitan injectors with Nathan checks and starting valves. Metallic packing is used on the piston-rods and valve-stems.

The total weight of this engine in working order is 146,500 lbs., of which 31,000 lbs. are carried on the truck and 115,500 lbs. on the drivers; an average of 19,250 lbs. per wheel.

The tender frame is of 9-in. channel iron. The tank is of steel and will hold 3,600 galls. of water. The tender is carried on two four-wheel trucks. The axles are of hammered iron, and have journals 5 in. in diameter and 8 in. long. The wheels are 33 in. in diameter, and are of the

double-plate, solid steel pattern made by the American Steel Wheel Company.

The general design of the locomotive and many of the details are well shown by the photograph.

A COMPOUND FREIGHT LOCOMOTIVE.

THE engraving given herewith is from a photograph of a compound locomotive built by the Brooks Locomotive Works, at Dunkirk, N. Y., and now in service on the Lake Shore & Michigan Southern Railroad. It is a ten-wheel engine built for freight service, and is of the two-cylinder compound type. The general design is shown by the photograph.

To give first a general description, the boiler is of the wagon-top type, built for a working pressure of 180 lbs., the material used being steel. The plates are $\frac{7}{16}$ in., $\frac{1}{2}$ in. and $\frac{9}{16}$ in.; the horizontal seams have lap joints and are qradruple riveted, and the circumferential seams are double riveted. The barrel is 52 in. in diameter, and there are 186 tubes 2 in. in diameter and 12 ft. long. The fire-box is 34 in. wide inside and 8 ft. long; the crown-sheet is supported by crown bars $5 \times \frac{3}{4}$ in. in section, and welded together at the ends. Feed-water is supplied by two No. 8 Monitor injectors. The water-space around the fire-box is 4 in. in front, 3 in. at the sides and back.

The driving-wheels are 56 in. in diameter, and the driving-axles have 7×8-in. journals. The main crank-pins are $4\frac{1}{2} \times 6$ in.; the intermediate coupling-rod pins are $5\frac{1}{4} \times 4\frac{1}{4}$ in., and the front and back pins $3\frac{1}{2} \times 3\frac{1}{2}$ in. The truck wheels are 28 in. in diameter and the truck axles have $4\frac{3}{4} \times 10$-in. journals. The rigid wheel-base is 8 ft.; the driving-wheel-base is 13 ft. 3 in., and the total wheel-base is 23 ft. 3 in.

The high-pressure cylinder is 17 in. in diameter and 24 in. stroke. The steam-ports are $16 \times 1\frac{5}{8}$ in. and the exhaust-ports 16×3 in., the width of bridges being $1\frac{1}{2}$ in. The valve has $\frac{5}{8}$ in. outside lap, $\frac{3}{16}$ in. inside clearance, and a maximum travel of $5\frac{3}{4}$ in. The lead in full gear is $\frac{1}{32}$ in.

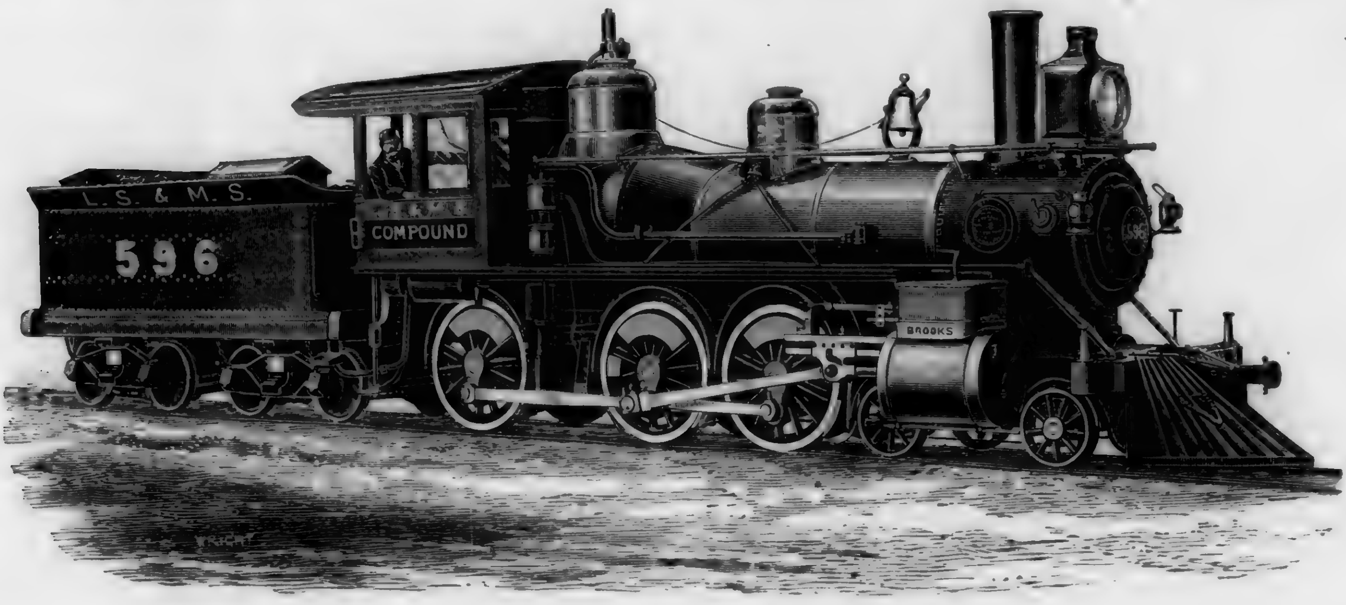
The low-pressure cylinder is $28\frac{1}{2}$ in. in diameter and 24 in. stroke. The steam-ports are $20 \times 2\frac{1}{4}$ in. and the exhaust ports 20×5 in. The valve has $\frac{1}{16}$ in. outside lap, $\frac{1}{4}$ in. inside clearance, and its maximum travel is 7 in. The lead in full gear is $\frac{1}{8}$ in.

The slide-valves are of the Morse balanced pattern. The United States metallic packing is used for the valve-stems.

The exhaust nozzle is single and is $4\frac{1}{2}$ in. in diameter. The smoke-stack is $13\frac{1}{2}$ in. inside diameter.

The especial feature of this engine as a compound is the use of two cylinders, the intermediate receiver and the intercepting valve. The ratio of the high to the low-pressure cylinder is 1 : 2.81; of the high-pressure cylinder to the receiver 1 : 4.5. The diameter of the intercepting valve is 7 in., and the smallest diameter of the reducing valve is 3 in.; the pipe supplying live steam to the reducing valve is $2\frac{3}{4}$ in.

The reducing valve, the most important feature, is Player's patent. This is shown in detail in figs. 18–27, which are taken from the patent drawings. In these figs. 18 and 19 show a section and plan of one arrangement of the valve; figs. 20 and 21 show another form; figs. 22, 23 and 24 show the valve in various positions; figs. 25, 26 and 27 show modified forms. The construction is shown by the drawings, and can, perhaps, best be explained by quoting the inventor's own description, as below:



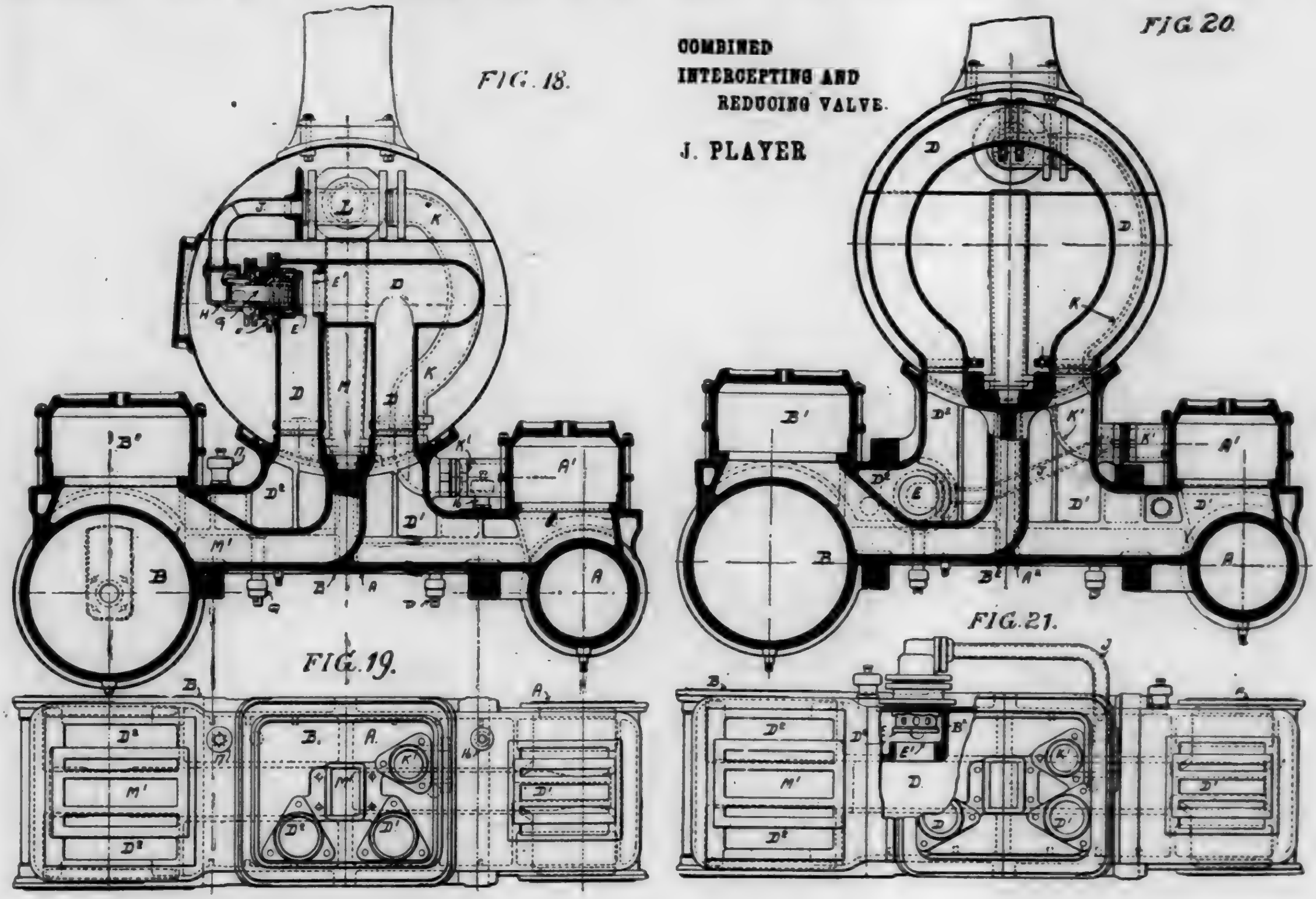
TWO-CYLINDER COMPOUND LOCOMOTIVE.

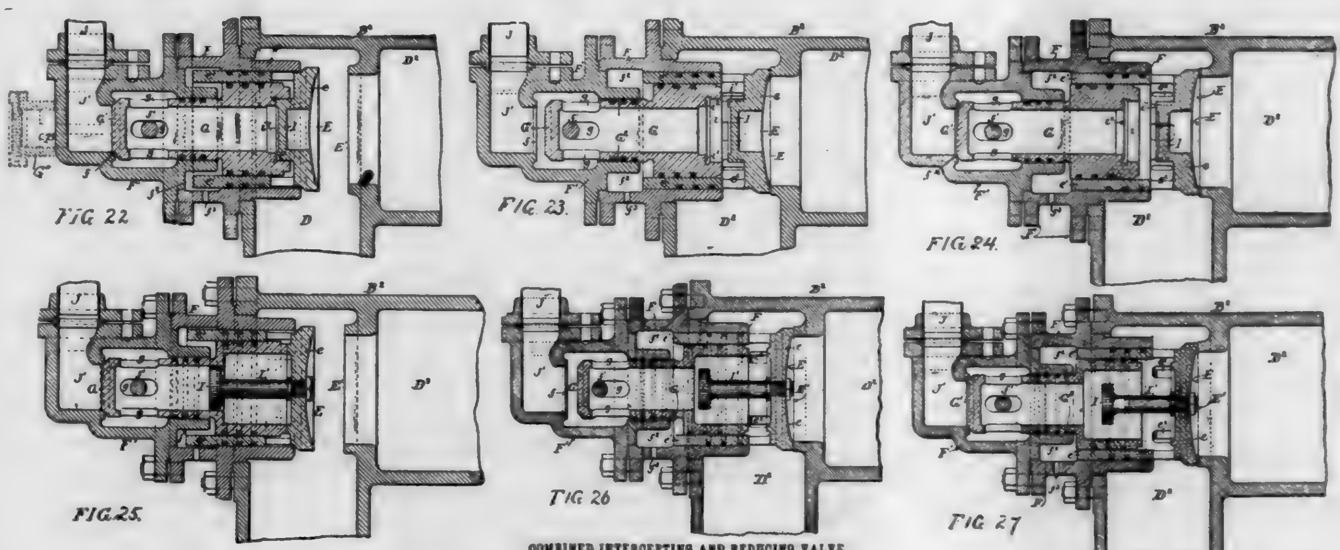
BUILT BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

This valve is intended for locomotives of the two-cylinder type with an intermediate receiver, but it is applicable also to a four-cylinder engine. The valve may be placed in the cylinder saddle, as shown in figs. 20 and 21, or in the receiver-pipe, as shown in figs. 18 and 19.

When the engine comes to a rest after running with the throttle shut, the intercepting-valve, unless provided with springs, will be found open and seated against the pressure-regulating valve, the pressure-regulating valve also being closed; but if the intercepting-valve is provided with springs it will be found closed against its seat and the pressure-regulating valve will be open. In practice, however, it has been found that these springs are unnecessary, and in order to secure a more sensitive action of the pressure-regulating valve the cut-off plunger *I* is provided, working within the chamber of the valve *G*. This keeps the pressure-regulating valve in a more accurate state of equilibrium during the admission of steam. When the throttle-valve is opened, live steam is admitted to the high-pressure steam-chest through the steam-pipe *K* and passages *K'*, and operates upon the high-pressure piston in the ordinary manner. At the same time steam is admitted to the high-pressure end of the pressure-regulating valve through the connecting-pipe *J*, causing the valve to open and, passing through the slots, thence through the hollow portion of the valve, causes the intercepting-valve to close against its seat, as shown. This steam flows through the passages in the intercepting-valve into the low-pressure steam-chest, and, acting upon the large end of the pressure-regulating valve, causes it to partially close as soon as the requisite pressure is obtained

and thereafter regulates the amount of steam admitted by the pressure-regulating valve, maintaining an even pressure. The reduced-pressure steam thus admitted acts upon the low-pressure piston in the ordinary manner. As soon, however, as the high-pressure cylinder has exhausted sufficient steam into the piston, until such time as the high-pressure end of the receiver becomes charged with exhaust steam from the high-pressure cylinder at approximately the same pressure, whereupon the intercepting-valve, acting in combination with the pressure-regulating valve, permanently cuts off any further supply of





COMBINED INTERCEPTING AND REDUCING VALVE
J. PLAYER

high-pressure end of the receiver to overbalance the intercepting-valve this valve opens automatically, at the same time locking the pressure-regulating valve against its seat. The exhaust steam from the high-pressure cylinder flows through the receiver and acts directly upon the low-pressure piston, the pressure of this exhaust steam, even when considerably reduced, being sufficient to keep the pressure-regulating valve closed through the action of the duplex valve at all times. It will thus be readily seen that with this improved combination live steam at a suitable working pressure is permitted to act upon the low-pressure piston at all times in starting, and that steam at this pressure is maintained in the low-pressure side of the receiver and prevented from working against the high-pressure live steam to the low-pressure cylinder, and permits the direct passage of the exhaust steam from the high-pressure into the low-pressure cylinder. This combination also prevents the passage of live steam admitted through the pressure-regulating valve from passing into the high-pressure end of the receiver, and thus acting upon the back of the high-pressure piston.

The engine weighs, in working order, 102,000 lbs., of which 75,000 lbs. are carried on the drivers. It has been in service nearly a year, with results so satisfactory that the Lake Shore & Michigan Southern Company has recently ordered several engines now being built by the Brooks Works to be compounded in the same manner.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.*

I.—PHOSPHORUS IN STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 400.)

In beginning the publication of Chemical Methods, it is our intention to take up first those methods which have to do with the analysis of iron and steel, since it is probable there will be the greatest differences between chemists on these methods, and also since the results involved are the most important. Still further, of the six substances which are usually determined in iron and steel—namely, carbon, phosphorus, silicon, manganese, sulphur and copper—it seems also probable that the phosphorus is the one subject to the most uncertainty, and we have accordingly taken hold of the phosphorus method first of all. Preliminary to the method which follows, we have during the past summer made some 200 or 300 determinations, trying to prove up various points, and the method as given below involves the best that we know on the subject at the present time. The following is the method which, it will be remembered, is designed to make a part of the specifications on which steel is bought:

PENNSYLVANIA RAILROAD COMPANY.

METHOD OF DETERMINING PHOSPHORUS IN STEELS.

OPERATION.

Put 1 gram of the steel in a 10 to 12-ounce Erlenmeyer flask and add 75 c.c. of nitric acid (1.135 specific gravity). When solution is complete, boil one minute and then add 10 c.c. of oxidizing potassium permanganate solution. Boil until the pink color disappears and binoxide of manganese separates, remove from the heat and then add crystals of ferrous sulphate, free from phosphorus, with agitation until the solution clears up, adding as little excess as possible. Heat the clear solution to 185° Fahrenheit and add 75 c.c. of molybdate solution, which is at a temperature of 80° Fahrenheit, close the flask with a rubber stopper and shake five minutes, keeping the flask so enclosed during the operation that it will lose heat very slowly. Allow it to stand five minutes for the precipitate to settle, and then filter through a 9-cm. filter and wash with acid ammonium sulphate solution, until ammonium sulphide, tested with the washings, shows no change of color. Dissolve the yellow phospho-molybdate on the filter in 5 c.c. of ammonia (0.90 specific gravity) mixed with 25 c.c. of water, allowing the solution to run back into the same flask and thus dissolve any yellow precipitate adhering to it. Wash until the washings and filtrate amount to 150 c.c., then add 10 c.c. strong C. P. sulphuric acid and dilute to 200 c.c. Now pass the liquid through a Jones reductor or its equivalent, wash and dilute to 400 c.c. and then titrate in the reductor flask with potassium permanganate solution.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no especial comment, except perhaps the shaking apparatus and the

REDUCTOR FOR STEEL TESTS.

modification of the Jones reductor. The accompanying cuts illustrate these two. The shaking apparatus, as will be observed, is a modification of an ordinary milk-shake machine, and is arranged to shake four flasks at a time, which is about all one operator can manipulate, without the solutions becoming too cold. The cut is about one-

* The first series of these articles was published in The Railroad and Engineering Journal, December, 1889–June, 1892. The present article is the second of a new series.

sixth the actual size of the apparatus. The flasks containing the solutions rest on a sheet of india-rubber about ¼ in. thick and are held in position by the coiled springs as shown. There is a recess in the spring arrangement to receive the cork of the flask. In the absence of a shaking apparatus the flasks may be wrapped in a towel and shaken by hand. Of course during use the door of the box is closed, the cut showing it open so that the interior may be seen. The modified reductor seems to work equally as well as the more elaborate apparatus. The cut is about one-fourth actual size. As will be seen the tube is fitted with two rubber corks, the top one of which holds the funnel and the bottom one a small tube which also fits into the rubber cork in the flask. Next to the bottom cork in the tube is a disk of perforated platinum; then about ¼ in. of clean white sand; then another perforated platinum disk, and then the tube is nearly filled with powdered zinc. At least half the zinc may be used out before it is necessary to refill.

SHAKING APPARATUS FOR STEEL TESTS.

Burettes can usually be obtained in the market which are sufficiently well made and graduated with sufficient care, so that their error can be ignored. Of course this point should not be overlooked.

The specific gravities of the reagents given are essential and the temperature at which the figures are correct is 59° Fahrenheit. In determining these gravities it is best to use a Westphal balance, but failing this a sufficiently delicate hydrometer can be used.

The oxidizing permanganate of potash solution is made as follows: To two liters of water add 25 grams of C. P. crystallized permanganate of potash, and allow to settle before using. Keep in the dark.

The molybdate solution is made as follows: Dissolve 100 grams of molybdic acid in 400 c.c. of ammonia (sp. gr. 0.96) and filter. Add the filtrate to 1000 c.c. of nitric acid (sp. gr. 1.20). Allow to stand at least 24 hours before using.

The acid ammonium sulphate solution is made as follows: To one-half liter of water, add 27½ c.c. of ammonia (0.96 sp. gr.) and then add 24 c.c. strong C. P. sulphuric acid, and make up to one liter.

The permanganate of potash solution for titration is made as follows: To one liter of water add two grams of crystallized permanganate of potash, and allow to stand in the dark not less than a week before using. Determine the value of this solution in terms of metallic iron. For this purpose 150 to 200 mg. of iron wire or mild steel are dissolved in dilute sulphuric acid (10 c.c. of strong C. P. acid to 40 c.c. of water) in a long-necked flask. After solution is complete, boil 5 to 10 minutes, then dilute to 150 c.c., pass the liquid through the reductor, and wash, making the volume up to 200 c.c. Now titrate with the permanganate solution. It is of course essential that the amount of iron in the wire or soft steel should be known. The standard in use in the Pennsylvania Railroad laboratory is a mild steel in which the iron is known by determining carbon, phosphorus, silicon, sulphur, manganese and copper, and deducting the sum of these from 100 per cent. Not less than two independent determinations should be made, and three are better. The figures showing the value of the permanganate solution in terms of metallic iron should agree to one-hundredth of a milligram in the different determinations. A very satisfactory method of making and keeping permanganate of potash solution is as follows: Have a large glass bottle holding say 8 liters and 2 of half the size. Paint the outside of these bottles with several coats of black paint or varnish. Fill the large bottle with the standard solution, and after it has stood a proper time, fill one of the smaller bottles from it without shaking and standardize. At the same time fill the second small bottle, and refill the large one. When the first small bottle is exhausted standardize the second one and fill the first from the stock. When this is exhausted standardize the first again and fill the second from stock, refilling again the stock bottle and so on. By this means a constant supply of sufficiently matured permanganate is always available. Of course if the consumption is very large, larger bottles or more of them may be required. Since changes of temperature affect the volume of all solutions, it is desirable that the permanganate solution should be used at the same temperature at which it was standardized. With the strength of solutions above recommended if the permanganate is used at a temperature of 20° Fahrenheit different from that at which it was standardized, the error amounts to less than 0.001 per cent. on a steel containing 0.10 per cent. of phosphorus.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.*

I.—PHOSPHORUS IN STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 400.*)

In beginning the publication of Chemical Methods, it is our intention to take up first those methods which have to do with the analysis of iron and steel, since it is probable there will be the greatest differences between chemists on these methods, and also since the results involved are the most important. Still further, of the six substances which are usually determined in iron and steel—namely, carbon, phosphorus, silicon, manganese, sulphur and copper—it seems also probable that the phosphorus is the one subject to the most uncertainty, and we have accordingly taken hold of the phosphorus method first of all. Preliminary to the method which follows, we have during the past summer made some 200 or 300 determinations, trying to prove up various points, and the method as given below involves the best that we know on the subject at the present time. The following is the method which, it will be remembered, is designed to make a part of the specifications on which steel is bought:

PENNSYLVANIA RAILROAD COMPANY.

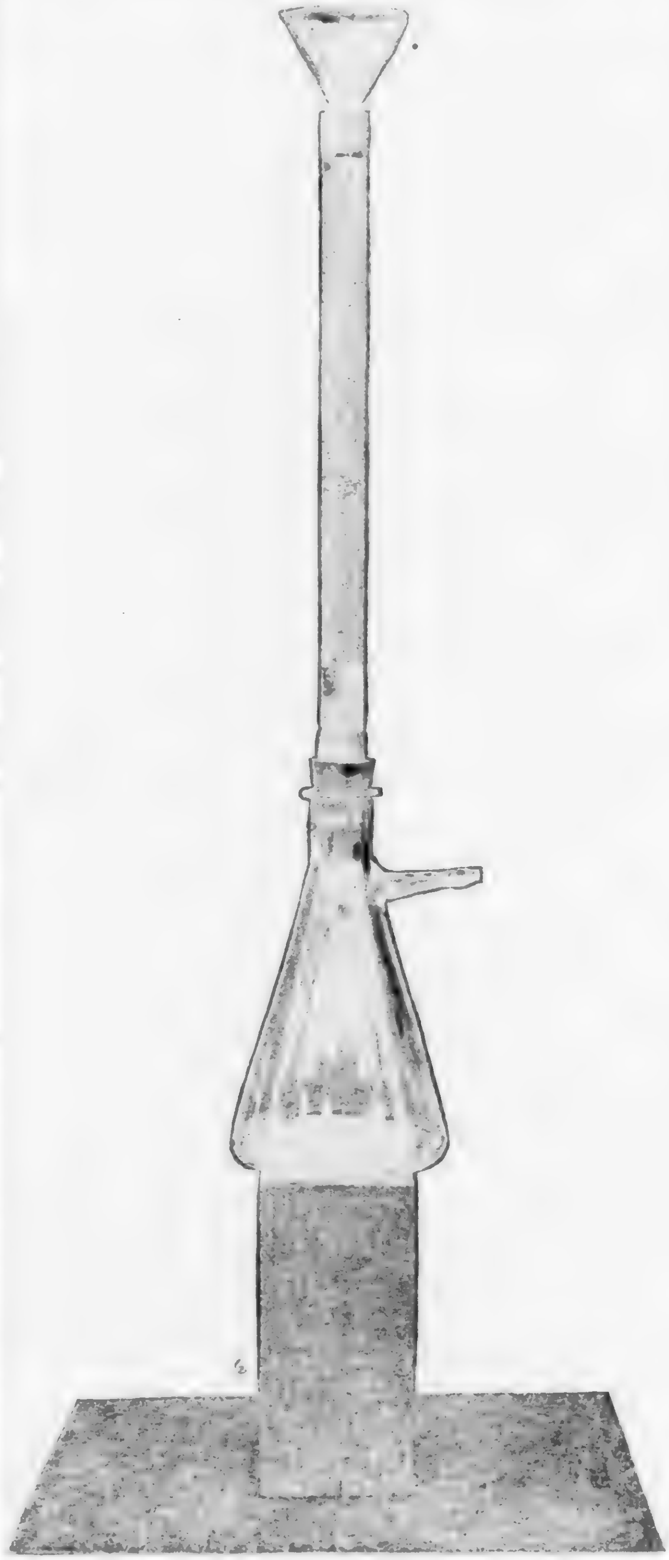
METHOD OF DETERMINING PHOSPHORUS IN STEELS.

OPERATION.

Put 1 gram of the steel in a 10 to 12-ounce Erlenmeyer flask and add 75 c.c. of nitric acid (1.135 specific gravity). When solution is complete, boil one minute and then add 10 c.c. of oxidizing potassium permanganate solution. Boil until the pink color disappears and binoxide of manganese separates, remove from the heat and then add crystals of ferrous sulphate, free from phosphorus, with agitation until the solution clears up, adding as little excess as possible. Heat the clear solution to 185° Fahrenheit and add 75 c.c. of molybdate solution, which is at a temperature of 80° Fahrenheit, close the flask with a rubber stopper and shake five minutes, keeping the flask so enclosed during the operation that it will lose heat very slowly. Allow it to stand five minutes for the precipitate to settle, and then filter through a 9-cm. filter and wash with acid ammonium sulphate solution, until ammonium sulphide, tested with the washings, shows no change of color. Dissolve the yellow phospho-molybdate on the filter in 5 c.c. of ammonia (0.90 specific gravity) mixed with 25 c.c. of water, allowing the solution to run back into the same flask and thus dissolve any yellow precipitate adhering to it. Wash until the washings and filtrate amount to 150 c.c., then add 10 c.c. strong C. P. sulphuric acid and dilute to 200 c.c. Now pass the liquid through a Jones reductor or its equivalent, wash and dilute to 400 c.c. and then titrate in the reductor flask with potassium permanganate solution.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no especial comment, except perhaps the shaking apparatus and the

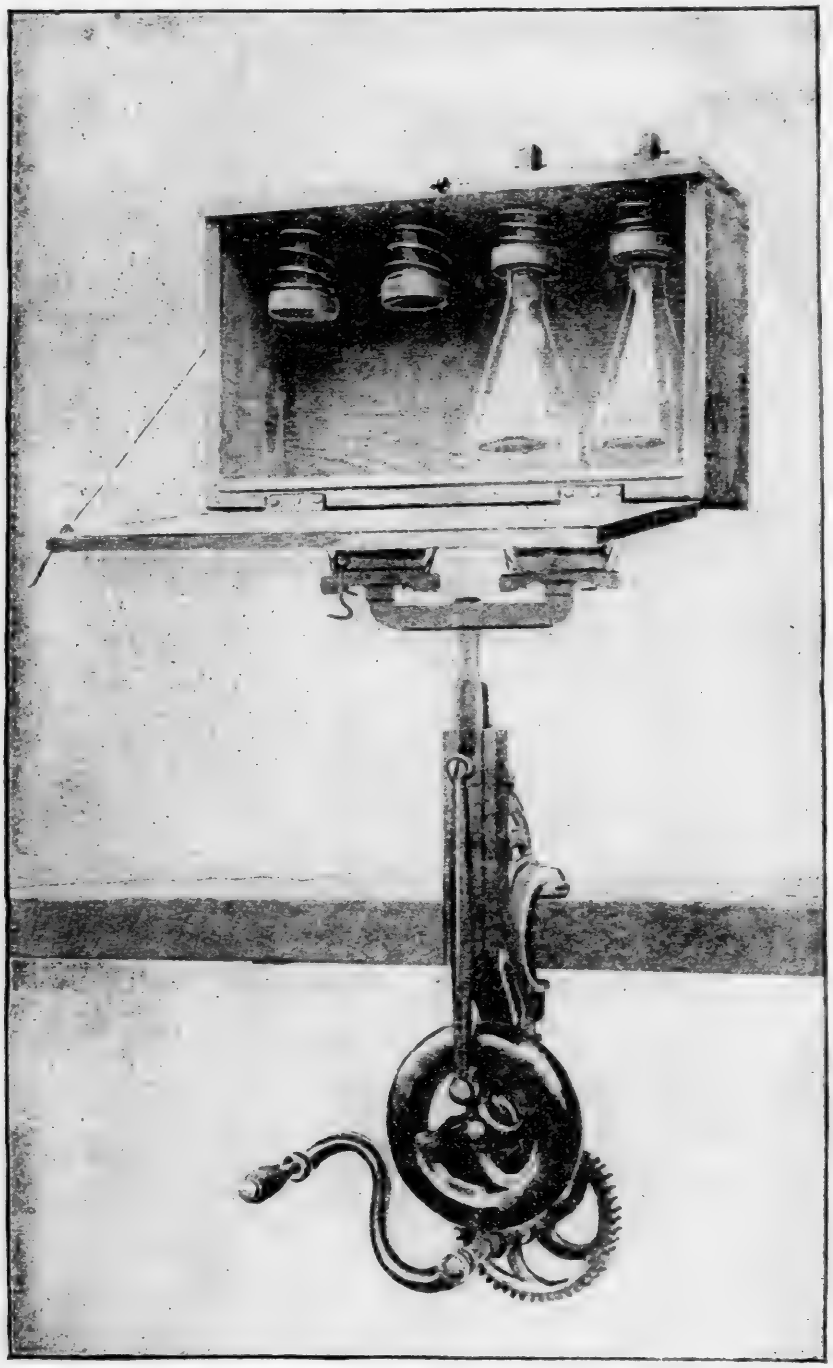


REDUCTOR FOR STEEL TESTS.

modification of the Jones reductor. The accompanying cuts illustrate these two. The shaking apparatus, as will be observed, is a modification of an ordinary milk-shake machine, and is arranged to shake four flasks at a time, which is about all one operator can manipulate, without the solutions becoming too cold. The cut is about one-

* The first series of these articles was published in The Railroad and Engineering Journal, December, 1889–June, 1892. The present article is the second of a new series.

sixth the actual size of the apparatus. The flasks containing the solutions rest on a sheet of india-rubber about ¼ in. thick and are held in position by the coiled springs as shown. There is a recess in the spring arrangement to receive the cork of the flask. In the absence of a shaking apparatus the flasks may be wrapped in a towel and shaken by hand. Of course during use the door of the box is closed, the cut showing it open so that the interior may be seen. The modified reductor seems to work equally as well as the more elaborate apparatus. The cut is about one-fourth actual size. As will be seen the tube is fitted with two rubber corks, the top one of which holds the funnel and the bottom one a small tube which also fits into the rubber cork in the flask. Next to the bottom cork in the tube is a disk of perforated platinum; then about ¾ in. of clean white sand; then another perforated platinum disk, and then the tube is nearly filled with powdered zinc. At least half the zinc may be used out before it is necessary to refill.



SHAKING APPARATUS FOR STEEL TESTS.

Burettes can usually be obtained in the market which are sufficiently well made and graduated with sufficient care, so that their error can be ignored. Of course this point should not be overlooked.

The specific gravities of the reagents given are essential and the temperature at which the figures are correct is 59° Fahrenheit. In determining these gravities it is best to use a Westphal balance, but failing this a sufficiently delicate hydrometer can be used.

The oxidizing permanganate of potash solution is made as follows: To two liters of water add 25 grams of C. P. crystallized permanganate of potash, and allow to settle before using. Keep in the dark.

The molybdate solution is made as follows: Dissolve 100 grams of molybdic acid in 400 c.c. of ammonia (sp. gr. 0.96) and filter. Add the filtrate to 1000 c.c. of nitric acid (sp. gr. 1.20). Allow to stand at least 24 hours before using.

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CALCULATIONS.

An example of all the calculations is given herewith. The soft steel employed in standardizing permanganate of potash solution in the Pennsylvania Railroad laboratory contains 99.27 per cent. metallic iron; 0.1498 gram of this contains therefore (0.1498 × 0.9927) 0.1487064 gram of metallic iron. This requires 42.99 c.c. permanganate solution, or one c.c. of permanganate solution is equal to (0.1487064 ÷ 42.9) 0.003466 metallic iron. But the same amount of permanganate solution used up in producing the characteristic reaction in this amount of metallic iron will be used up in reaction with 90.76 per cent. of the same amount of molybdic acid. Hence one c.c. of permanganate solution is equivalent to (0.003466 × 0.9076) 0.003145 gram of molybdic acid. But in the yellow precipitate obtained as above described, the phosphorus is 1.90 per cent. of the molybdic acid. Hence one c.c. of permanganate solution is equivalent to (0.003145 × 0.0190) 0.0000597 gram of phosphorus. If therefore, in any sample of steel tested as above, the yellow precipitate requires 8.6 c.c. of permanganate, the amount of phosphorus in that steel is (0.0000597 × 8.6) 0.051 per cent.

NOTES AND PRECAUTIONS.

It will be observed that the method given above oxidizes the phosphorus in the iron by means of nitric acid, completes and perfects this oxidation and possibly neutralizes the effect of the carbon present by means of permanganate of potash, and then separates the phosphoric acid from the iron by means of molybdic acid. The molybdic acid in the yellow phospho-molybdate is subsequently determined by means of permanganate of potash, the phosphorus being determined from its relation to the molybdic acid in this precipitate. The method given above applies to steel and wrought iron, but is not yet recommended for pig iron.

It is hardly necessary to say that all the chemicals and materials used in the analysis are assumed to be free from impurities that will injuriously affect the result.

The 1.135 specific gravity nitric acid apparently oxidizes the phosphorus just as successfully as a stronger one, while by its use solution is sufficiently rapid, and there is less trouble during the subsequent filtration due to silica.

If the solution is boiled one minute after solution is complete it will use up much less permanganate than if the preliminary boiling is omitted.

Care should be taken to secure a crystallized ferrous sulphate free from phosphorus. The commercial salt is apt to be contaminated. It should be added in small crumbs so as to avoid excess. If too much has been used a few drops of permanganate can be added to oxidize it.

The temperature at which the molybdate solution is added to the iron solution and the resulting temperature have an influence on the result. The directions should be closely followed, a good thermometer being used to determine temperatures. Never add the molybdate solution and then heat.

In washing the yellow precipitate it shows some disposition to crawl up to the top of the filter. Care should be taken therefore to have the filter fit the funnel so closely that even if the precipitate does crawl over the top it will not be lost while washing the filter completely to the top. It is very easy to leave enough molybdic acid in the top of the filter, even though the washings are tested, to cause an error of 0.005 per cent. in the determination.

The amount of molybdate solution given above is enough to convert all the iron into molybdate, and still leave enough to carry down the phosphorus.

It is best to make up molybdate solution frequently, as it slowly changes on standing. We think it unadvisable to use a molybdate solution over 10 days old. It is best to keep the molybdate solution in the dark at a temperature not above 80° to 85° Fahrenheit. The solution should always be filtered before using. Much of the so-called molybdic acid of the market is molybdate of ammonium or molybdate of some other alkali. This fact cannot be ignored in making up the molybdate solution. A series of experiments with various molybdic acids and alkaline molybdates obtained in the market indicates that if the amount of molybdic acid in the solution is that called for by the formula, irrespective of whether this amount is furnished by pure molybdic acid or any of the commercial molybdates referred to, the result will be much nearer the truth than if this is not done. Good molybdic acid is best, but the alkaline molybdates can be used. The amount of molybdic acid in these molybdates can readily be determined by dissolving 0.1000 gram in 100 c.c. of water to which a little ammonia has been added and filter. Now add 10 c.c strong C. P. sulphuric acid, dilute to 200 c.c. and pass through the reductor. Wash and dilute to 400 c.c. and titrate with permanganate. The method given in the calculation above enables the amount of molybdic acid to be determined.

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Samples of steel in which the phosphorus has been determined will be sent to parties asking for the same in order to enable them to make such comparisons as they may desire.

In formulating the method given above, the published work of Emerton, Wood, Drown, Hundeshagen, Colby, Shimer, Handy and Jones has been freely consulted and used. It would be difficult to state in detail what is due to each.

THEODORE N. ELY,
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In the January number some discussion of this method will be given, showing the reasons for adopting it.

(TO BE CONTINUED.)

A COMPOUND FREIGHT LOCOMOTIVE.

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The Railway Report attracts more attention than any other similar document submitted to Parliament. The results of the working of the railways and tramways are closely watched, not only locally but also by the British bondholders, who, to a certain extent, regard them as their security.

Briefly stated, our railways cost £33,312,608; during the past year they earned £3,107,296, and the working expenses amounted to £1,914,252, thus leaving a net profit on working of £1,193,044, equal to 3.58 per cent. interest on capital. These figures clearly indicate the extent to which the railways are used by the, comparatively speaking, limited population of the colony.

On June 30 there were 2,185 miles open for traffic, the passenger journeys reached 19,918,916, and the tonnage of goods carried 4,296,713. To convey this traffic 8,356,096 train miles were run, the earnings per train mile being 89.25*d*., the working expenses 54.98*d*., and net profit 34.27*d*.

During the past three years considerable improvements in the rolling stock and permanent way have been effected; the regular passenger trains now present a pleasing appearance by their uniformity, while the superior fittings in the carriages, and the improved permanent way, tend to increase the comfort of traveling.

The passenger stock numbers 1,054 vehicles, the goods stock 10,455, and the locomotives 489.

The attention given to the interlocking and the permanent way has considerably increased the safety of the railway men who have to do with the running of the trains, and the traveling public; thus, while in October, 1888, on only 28 miles of line the traffic was worked under the absolute block system, we have at present 754¼ miles worked under that system, while the number of places which have points and signals interlocked increased during the same period from 104 to 260.

The report also furnishes some interesting facts regarding the suburban passenger fares. It is rather surprising to note that, although higher rates for wages and other charges prevail in this colony, the fares are considerably lower than those in force on the principal English lines for similar distances. It may also be remarked, that our grain rates are below those of the other Australian colonies.

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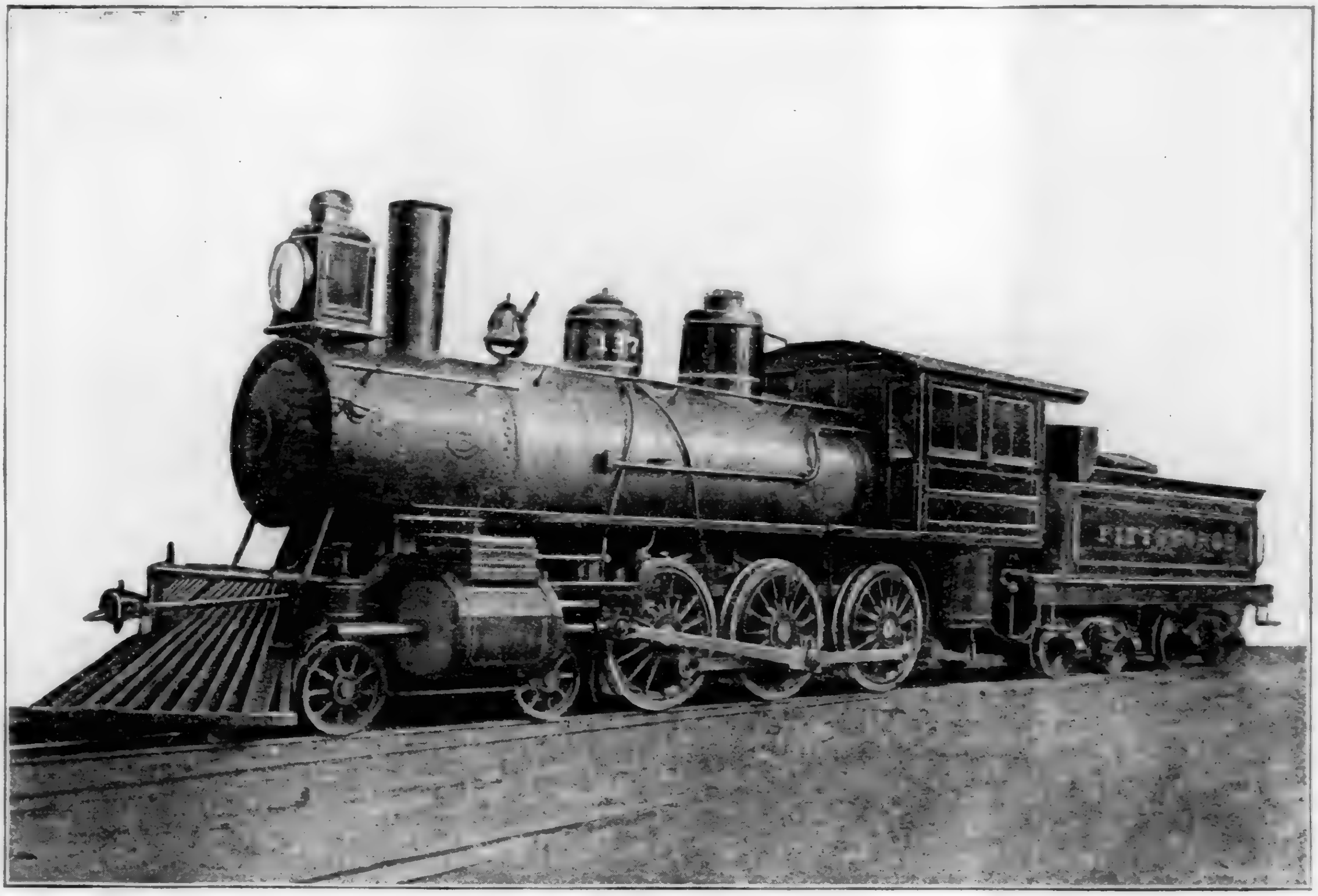

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The Railway Report attracts more attention than any other similar document submitted to Parliament. The results of the working of the railways and tramways are closely watched, not only locally but also by the British bondholders, who, to a certain extent, regard them as their security.

Briefly stated, our railways cost £33,312,608; during the past year they earned £3,107,296, and the working expenses amounted to £1,914,252, thus leaving a net profit on working of £1,193,044, equal to 3.58 per cent. interest on capital. These figures clearly indicate the extent to which the railways are used by the, comparatively speaking, limited population of the colony.

On June 30 there were 2,185 miles open for traffic, the passenger journeys reached 19,918,916, and the tonnage of goods carried 4,296,713. To convey this traffic 8,356,096 train miles were run, the earnings per train mile being 89.25*d.*, the working expenses 54.98*d.*, and net profit 34.27*d.*

During the past three years considerable improvements in the rolling stock and permanent way have been effected; the regular passenger trains now present a pleasing appearance by their uniformity, while the superior fittings in the carriages, and the improved permanent way, tend to increase the comfort of traveling.

The passenger stock numbers 1,054 vehicles, the goods stock 10,455, and the locomotives 489.

The attention given to the interlocking and the permanent way has considerably increased the safety of the railway men who have to do with the running of the trains, and the traveling public; thus, while in October, 1888, on only 28 miles of line the traffic was worked under the absolute block system, we have at present 754¼ miles worked under that system, while the number of places which have points and signals interlocked increased during the same period from 104 to 260.

The report also furnishes some interesting facts regarding the suburban passenger fares. It is rather surprising to note that, although higher rates for wages and other charges prevail in this colony, the fares are considerably lower than those in force on the principal English lines for similar distances. It may also be remarked, that our grain rates are below those of the other Australian colonies.

The effect of extending the railways into the interior,

and so developing the resources of the colony, may be seen from the following table :

	1857.	1892.
Population of the Colony	283,000	1,182,500
Miles open	40	2,185
Persons to each mile of line	7,075	540
Passengers carried	329,019	19,918,916
Journeys per head of population	1.16	16.85
Tonnage of goods	20,847	4,296,713
Tons carried per head of population	0.074	3.634

Railway construction almost ceased in 1889, and during the three years ending June 30, 1892, only 13 miles were opened for traffic, but since that date the line from Nyngan to Cobar, 81 miles, was opened. The Culcairn-Corowa line, 47½ miles, will also be opened in a few days, and, in addition, there are 203½ miles under construction, 97 miles of which are expected to be taken over from the contractor during the current year. On October 1 there will be 2,313½ miles available for traffic—2,162 single line, 143 double, and 8½ quadruple.

The number of persons employed in the railway and tramway form the large army of 11,789 men.

The tramway system has also shown improvement during the past year, the fares collected on the city and suburban trams alone amounting to 65,299,063. The cost of the whole of the lines, 48 miles, is £1,099,659. The gross earnings amounted to £305,090, the working expenses to £248,591, leaving the sum of £56,499, as the net receipts, equal to 5.28 per cent. on capital invested, being an increase of 3.30 per cent. over the year 1888.

PATENTS AT THE COLUMBIAN EXPOSITION.

THE following letter was some time ago addressed to the Inventors and Manufacturers of the United States by Hon. W. E. Simonds, Commissioner of Patents. It was published in the *Official Gazette* of the Patent Office, and certainly deserves attention. It is of interest as showing what is to be done at Chicago next year, and it is to be hoped that the desired co-operation will be generally given :

It is the intention of the Patent Office to make at the World's Columbian Exposition at Chicago in 1893 an exhibit which will show that great advance in the several arts which is due, in large measure, to the encouragement and support afforded by our patent system. This exhibit is to consist of models of patented inventions, which will be carefully selected, to show as far as is possible the inception of each art, the stages through which the art has advanced, and the final development reached at the present time. This display of typical inventions, embodied in concrete form and properly arranged, will, it is believed, constitute a grand historical exhibit of the progress of the useful arts and one which will be of great interest not only to inventors and manufacturers, but to the public generally.

The Office collection of models has been seriously impaired by fire, and is further incomplete by reason of the fact that models have not generally been required or received during the last ten years. The Office is not, therefore, in possession of the models of many valuable inventions which might properly be included in such an exhibit, and without which, indeed, the exhibit would be incomplete. The limited appropriation for this exhibit will not permit the Office to make such models. An urgent appeal is therefore made to all inventors and manufacturers to come to the assistance of the Office in this matter, either by loans of models already built or by the construction of such models not in the possession of the Office as should properly be placed in such a collection. Of course, where models are loaned to the Office all proper credit will be given both in labels and catalogues to the parties by whom the loans are made, and such disposition will be made of the models after the close of the exhibit as the owners shall direct. Many inventors and manufacturers have already indicated a willingness to co-operate with the Office in this matter, and it is confidently expected that such a response will be made to this general appeal as will assure the unparalleled success of this attempt to graphically and concretely show the development of American invention.

THE RECENT SURVEY OF ST. LOUIS.

(Condensed from paper by B. H. Colby before the Engineers' Club of St. Louis.)

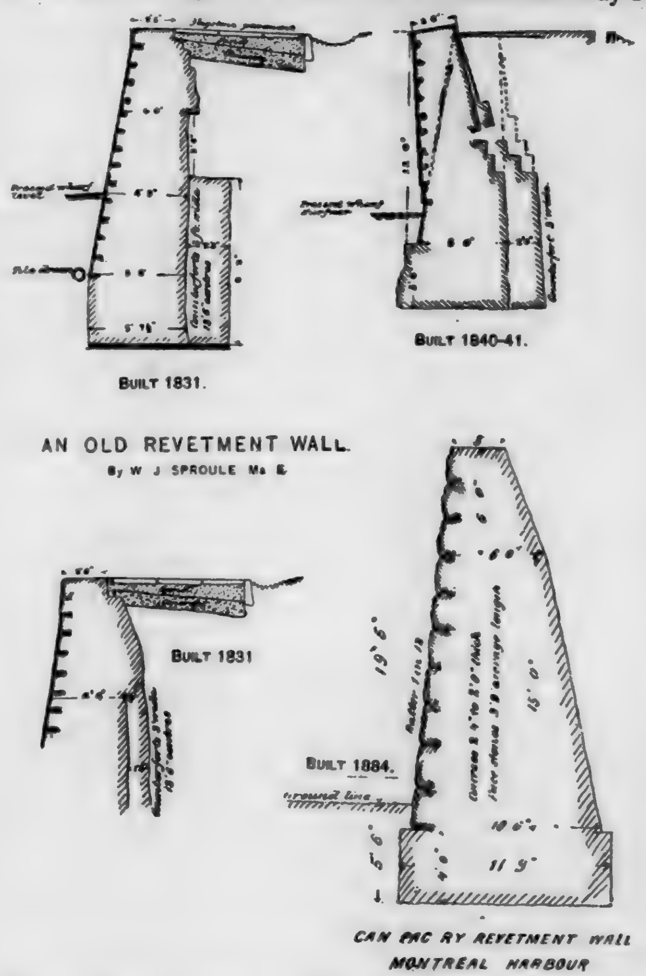
IN this interesting paper, as reported in the proceedings of the Club, Mr. Colby gave the geodetic basis on which the work was founded, and the means adopted for securing monuments and bench marks on roofs, graveyards and in the streets. He then specified the instruments used : a Gambe, a Fauth and two Buff & Berger transits, all reading to 10 seconds. The method of taking multiple readings of the angles was described on the repetition system. The area already triangulated, exceeding 27,000 acres, was described, and the number of stations occupied, which averaged two stations to the square mile. The base-line used was from the old Water Tower to the City Insane Asylum, which has a length of almost six miles. Mr. Colby recommended that the granite monument recently erected in Forest Park, near the weather station, be hereafter adopted for the city datum, in lieu of the old city directrix, which had been destroyed. He stated that the error of closure in the triangles averaged 3.7 seconds and the mean error per angle was 1.2 seconds. The general system of triangulation was to carry a series of primary triangles from the base-line to the extreme limits of the city, with an average length of sides of about two miles, and then fill in the intermediate ground with small secondary triangles. The method of keeping notes and making computations was then described. He mentioned that pole-targets, which were difficult to see on account of the smoke, and were tampered with by mischievous boys, were replaced by heliotropes or flash signals, a very simple and yet effective design being employed. The flash system gave much better closures of the triangles, as the average was 4.6 seconds with the poles, and 2.7 seconds with flash signals, or an average of both systems of 3.7. The heliotropes also permitted the Morse alphabet to be used in telegraphing from station to station. The method of carrying on precise leveling was then described, and the instruments employed were exhibited. In all 743 benches have been established, or 12 per square mile, mostly on the stone sills of the buildings, the location of which is printed every year in the annual report of the Sewer Commissioner. The average error has been 0.001 ft. per mile and the maximum permitted was 0.009 ft. per mile. If the error of closure was larger, the work was rerun. He then gave a new theory, based on studies made by Mr. E. J. Jolley, of the constant error found in precise leveling, which he explained as being due to always holding the eye-end of the level tube in carrying it, and therefore causing a local expansion of the eye-end of the tube that diminished the longer the instrument was used at a station, and hence the error was always greatest on the back sight. He stated that the topographic work was carried on with true azimuths. He gave the results of some stadia observations made after 4 P.M., which showed that the refraction error is so great as to make stadia more unreliable before 10 A.M. or after 4 P.M. ; an error of 0.2 ft. was found in 200 meters. He prefers to keep the topographic notes in the form of a few brief descriptions rather than by sketches. The methods employed in plotting were explained and a special protractor and slide rule exhibited. Mr. Colby also spoke of the different methods of graduating stadia boards, and gave some results that showed a marked tendency to error by the point system. The paper gave the results of carrying a stadia survey around the perimeter of St. Louis that covered a distance of 40.4 miles ; 306 stations were occupied, with an average length of 211 meters per station. The maximum error in azimuth was 12 ft. 3.5 in. at a distance of 34.9 miles, and the closing error was 8 ft. 2 in. The error in altitude in closing, after running the 40.4 miles, without checking on any intermediate benches, was 0.64 ft., with a maximum of 1.37 ft. at the 27th mile. The

cost of the triangulation, topography, leveling and office work, covering all expenses for 815 working days, amounted to about $35,000, at a cost of $1.15 per acre, or 14.5 cents per lot. The work was carried on by four engineers, with assistants, but only one party was in the field at a time, the others being busy in the office.

AN OLD REVETMENT WALL.

(Paper by W. J. Sproule, M.E. From the *Transactions* of the Canadian Society of Civil Engineers.)

THE old revetment wall along the city front in Montreal harbor is a very instructive example for civil engineers—more instructive than modern examples of massive masonry which show no signs of failure, and in which there may be



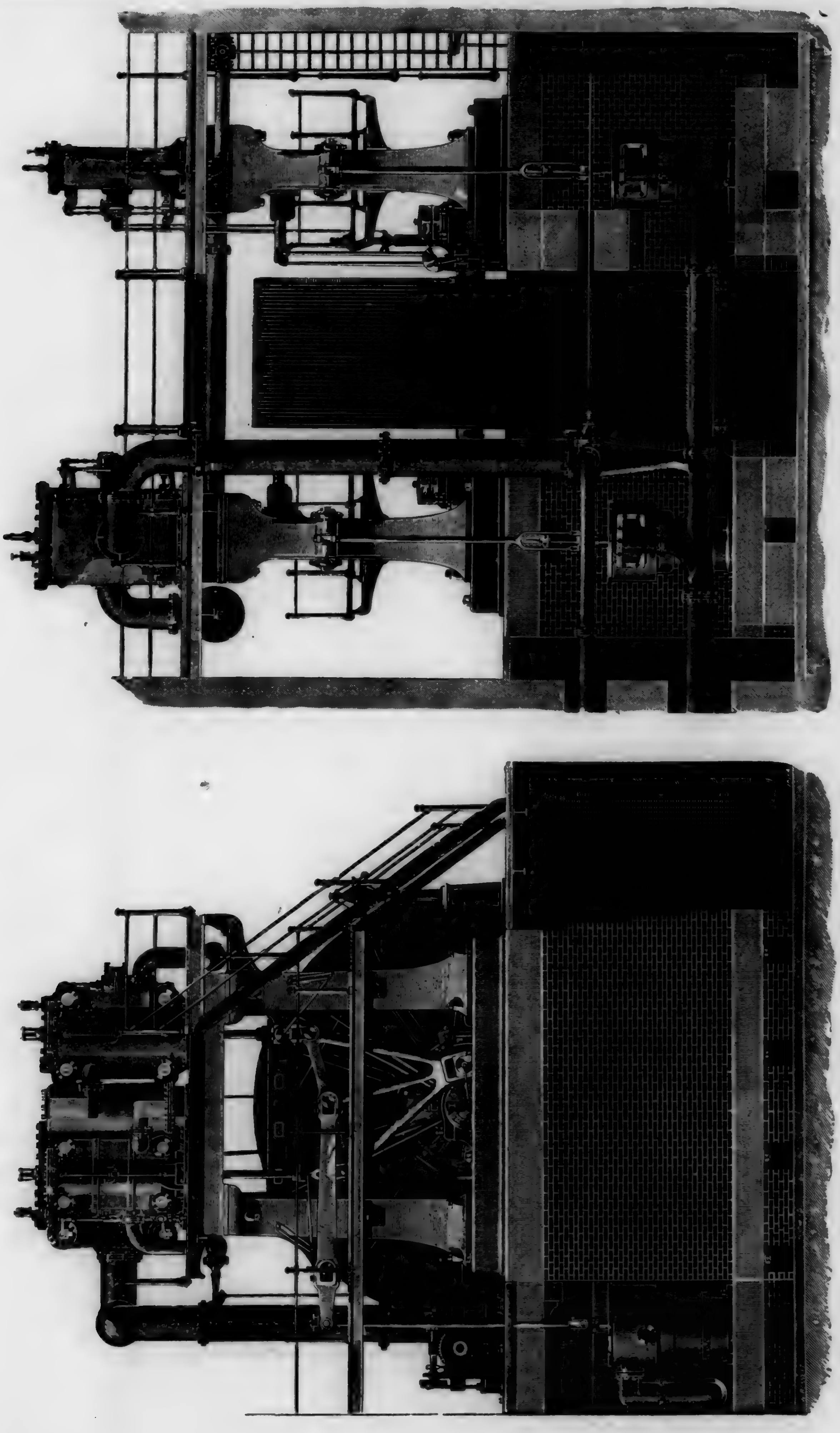
much surplus strength, and hence much unnecessary capital buried. It is an example of a wall so nearly equal to the requirements that part of it remains in good condition, while part has failed. The accompanying cross-sections show that the wall is much lighter than the practice of the present day warrants for similar situations, as is seen by comparing its cross-section with that of the Canadian Pacific Railway revetment wall recently built, and yet, after 50 years' duty, a considerable part of the wall is but little disturbed, and with a similar rate of degeneration would not be in bad condition 50 years hence, while part has failed so badly that it became unsafe, and timber props were resorted to several years ago. Part of the wall was built in 1831 and part in 1840–41. The failure during recent years has been very gradual, and the displacement probably nearly equal from year to year. Parts of both the older and newer portions of the wall have failed. Their cross-sections differ but little. This seems to indicate that the wall of 1831 had not shown signs of failure in 1841, otherwise the newer wall would likely have been built heavier. The wall is an ordinary retaining wall to support a city street. In the rear the ground rises rapidly in part, and in part is level for a considerable distance back. The wall is about one mile long, and on the harbor side is bare for a height of about 10 ft. from the wharf level to the coping.

In the beginning of winter, but always after a considerable interval of severe frost, in which the thermometer usually goes below zero, the river rises until the wall is partly immersed, the average height reached by the river at the "taking" of the ice being, for the last 40 years, a level within 5 ft. of the coping of the wall, varying, however, much from this level, often being lower and frequently nearly up to the coping. After the ice becomes stationary on the river the water falls gradually, and usually recedes from the foot of the wall, but at times remains for a long period in winter 1 to 3 ft. upon the face of the wall, fluctuating 1 to 2 ft. with variations in the temperature of the air. Part of the wall in this way is often exposed to temperatures 15° to 20° below zero after being immersed in water for days or weeks. But this does not seem to be the determining cause of failure, for the best and worst parts of the wall have been equally exposed to these conditions. The masonry on the inclined surface of the ramps, however, at about 1 to 3 ft. above wharf level is much displaced. The wall is built of limestone from quarries in the vicinity of Montreal. A few stones are cracked and somewhat weathered, but sufficient disintegration has not taken place in the stones themselves to perceptibly affect the general stability of the structure. The face is bush-hammered ashlar backed with rubble masonry. The face courses vary from 10 in. to 13 in. in thickness, but are in general 11 or 12 in. thick, and the stones in certain parts average 3 ft. in length; in other parts, 3 ft. 5 in. The bed joints average 0.22 in. in thickness. The coping stones average 5 ft. 2 in. in length, 12 in. in thickness and 2 ft. 6 in. in width. The wall has failed by sliding on the joints, especially at 8 to 10 ft. down from the coping or 1 to 2 ft. above the wharf, and by revolving on the joints, but as no systematic observations are available, it is uncertain whether these two motions have taken place simultaneously, or that the revolving began after the sliding movement had seriously affected the equilibrium of the wall. The sliding movement amounts to 5 in. in a single course in certain places, and a very slight displacement on joints seems to have taken place even in the best portions of the wall, but are here so slight as to make it uncertain whether the irregularities observable are due to imperfections in the setting or to subsequent movement. The mortar seems to have lost all its bonding strength, and as picked from the joints appears as a granulated mixture of earthy materials and lime. No openings or weepers appear on the face of the wall to drain water from behind. Where excavations have been made near the best parts of the wall the foundation is a coarse sand, apparently the old river beach, and this porous material no doubt has served a useful purpose in draining the wall, but the examinations have not yet been extensive enough to warrant the conclusion that the superior condition of the wall here is wholly due to this cause. Fortunately the wall has served its purpose, and must be taken down and entirely obliterated in carrying out the general harbor improvement project lately adopted, and this would be necessary, even if the wall were in the best condition. When this is done, something more may be learned of the weak points of the wall, and of the causes that preserved or destroyed it.

A QUADRUPLE-EXPANSION ENGINE.

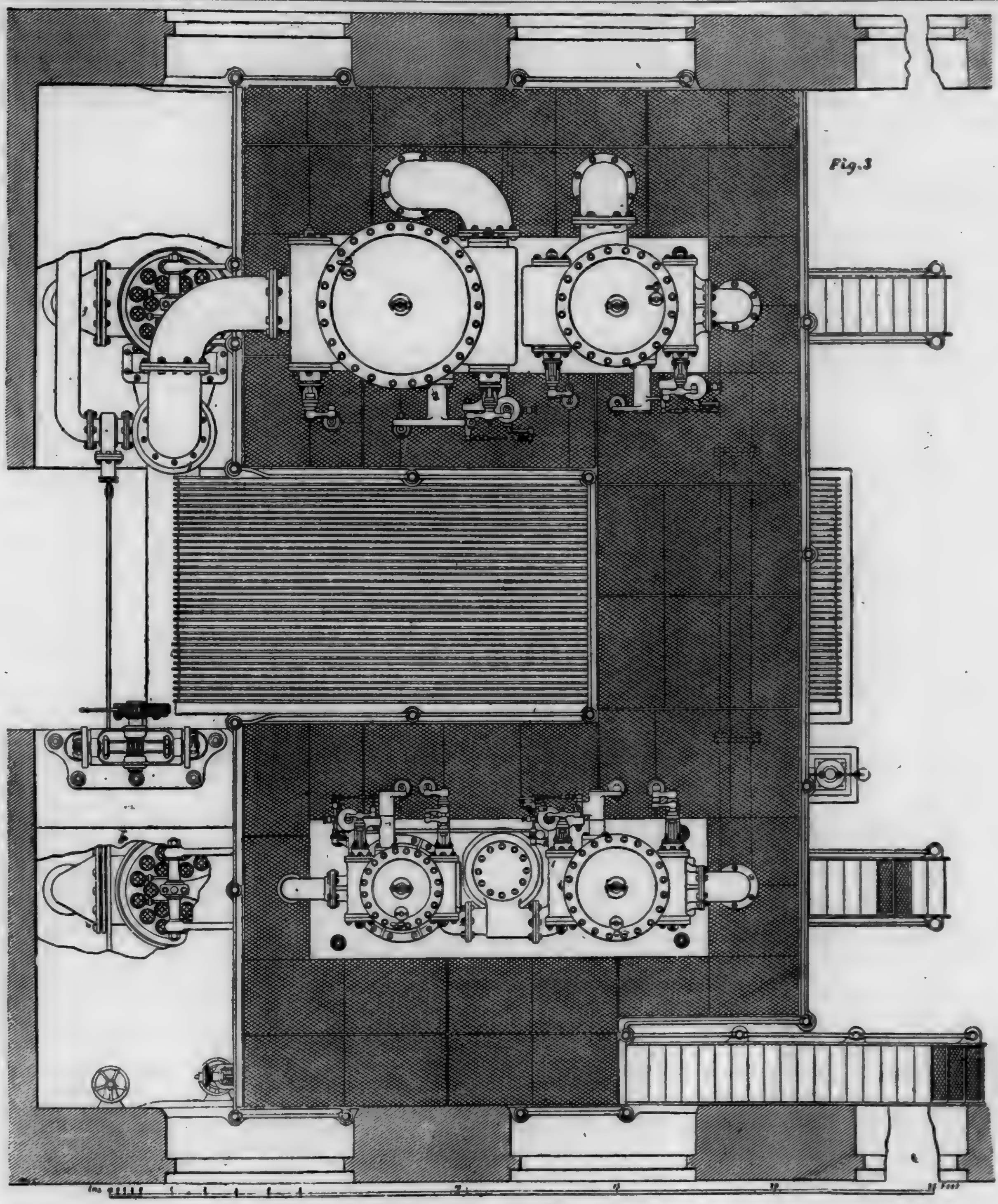
(From London *Engineering*.)

WE illustrate herewith an engine which is remarkable as being an application of the system of quadruple compounding to land engines. For four or five years quadruple-expansion engines have been fitted to steamers by several firms of marine engineers, and the economical results attained have suggested to Messrs. John Musgrave & Sons, of Bolton, England, the idea of applying this type for driving spinning machinery. Curiously enough, while the three-throw crank-shaft has been found most suitable for triple-expansion engines, few engineers have thought



QUADRUPLE-EXPANSION ENGINE FOR MILL WORK.

BUILT BY JOHN MUSGRAVE & SONS, BOLTON, ENGLAND.



QUADRUPLE-EXPANSION ENGINE FOR MILL WORK.

of using a four-throw crank with a quadruple engine. Various forms have been adopted, the two higher pressure cylinders being usually placed above the lower pressure cylinders, with two cranks. Messrs. Fleming & Ferguson, of Paisley, Scotland, have, however, adopted a unique arrangement, and the distinctive features of their design have been followed in Messrs. Musgrave's engine.

A reference to the plan given herewith will show that the cylinders are disposed in pairs on each side of the fly-wheel or rope drum, the two higher pressure cylinders being on one side and the two lower pressure cylinders on the other. The cross-heads of each pair of cylinders are connected by means of a pair of links and a triangular connecting-rod, as shown in the side elevation. The two cranks of the engine being opposite each other, the weights of the two sets of reciprocating parts balance each other. Although the cross-heads of the two cylinders are connected to one crank, they are never at the ends of their respective strokes at the same time, so that there are no dead centers to the engine. The turning effort, indeed, is the same as if the cross-heads were connected to cranks set nearly at right angles to each other. In other words, when one piston is at the end of its stroke the other is nearly in its central position and has a very effective leverage to turn the crank. Besides, the strains on the crank are gradually changed around the crank-pin from one side to the other, and never suddenly reversed, as with an ordinary engine, so that the vibration or jarring is minimized. The triangular connecting-rod vibrates on a pin in the ends of a pair of levers swinging on a fixed center outside of the frame. Extensions of the levers are made use of to work the air pumps, as shown in the engravings. The arc formed by this swinging lever, as well as the circular path of the crank pin, gives the end of the triangular rod a vibrating motion, so that the ends of the rods move vertically and thus reduce the pressure on the guides.

The engine is of the vertical inverted type, and its gen-

eral arrangement is very compact, as will be understood from the drawings. The cylinders are all provided with Corliss valves, the admission valves for the high-pressure and first intermediate being under the control of the governor, which may vary the point of cut-off from nothing to three-fourths of the stroke; the cut-off in the other two cylinders is adjustable by hand. All the admission valves are provided with Musgrave's patent trip motion. The arrangement of bed-plates, uprights and the framing generally will readily be understood from the engravings.

The high-pressure cylinder is 18 in., the first intermediate 26 in., the second intermediate 37 in. and the low-pressure 54 in. in diameter, all being 54 in. stroke. The ratios of the high-pressure to the other cylinders are thus 1 : 2.09 for the first, 1 : 4.23 for the second, and 1 : 9.00 for the low-pressure. The engine is expected to make 80 revolutions per minute in ordinary work, making the piston speed 720 ft. per minute. The working pressure will be 200 lbs.

There are two air pumps, each 26 in. diameter of bucket and 15 in. stroke. The main shaft is 16½ in. in diameter, and the bearings are 15 in. in diameter and 30 in. long. The shaft center is 19 in. in diameter. The crank-pin bearings are 9 in. in diameter and 10½ in. long.

The rope drum or driving-wheel is 21 ft. in diameter, and its face has 36 grooves, made for ropes 1⅝ in. in diameter. At 80 revolutions per minute the speed of these driving ropes will be about 5,280 ft., or a mile a minute.

This engine, when working with steam at 200 lbs. pressure and when fully loaded, is expected to develop 1,600 H.P. It is built for the Peel Spinning Company, at Bury, England, and is to run a mill containing 104,000 spindles.

It may be further noted that Messrs. Musgrave & Sons are building several engines of the same type for other mills.

THE CHESAPEAKE & DELAWARE CANAL.*

(Condensed from lecture by Professor Lewis M. Haupt before the Franklin Institute, Philadelphia.)

THE peninsula separating the Chesapeake from the Delaware extends southwardly 175 miles from the narrow neck of land which the canal traverses, while the distance across is but 13⅝ miles. Prior to the railroad era the importance of piercing this barrier and thus saving over 300 miles in the journey from Philadelphia to Baltimore by water was fully realized.

The Canal Company was incorporated in Maryland in 1799, and work was begun in 1804, but little progress was made until after the completion of the Erie Canal in 1825. Judge Benjamin Wright was then appointed Consulting Engineer, and pushed the work so vigorously that in September, 1829, barges passed through, and on October 17, 1829, it was officially opened with imposing ceremonies.

The magnitude of this undertaking at so early a date can scarcely be appreciated at the present stage of applied science. In the "Deep Cut," which is nearly 4 miles long and 76 ft. deep at its highest point, there were 3,500,000 cubic yards of earth which were removed and deposited beyond the sides of the cut, making the present height in some places 100 ft. There were difficulties from landslides and bottomless marshes, so that the excavation and fill exceeded the original amount by over 10 per cent., yet the entire work was rapidly completed at a cost of $2,250,000, or $161,000 per mile.

The general dimensions of the trunk of this original canal were the same as those of to-day: 66 ft. wide at the surface, 36 ft. at the bottom, and 10 ft. deep, while the locks were 100 ft. long and 22 ft. wide; but in 1854, or a quarter century later, they were enlarged to 220 ft. in length by 24 ft. in width, which dimensions they still retain, although much too small for the vessels of to-day.

There are two levels to surmount; the first extending from Delaware City, where there is a tidal lock of 6 ft. lift, to St. George's, 4½ miles; the second reaches from St. George's lock, with its 10 ft. lift, to Chesapeake City, about 9 miles. Here there is a single lock of 16 ft. descent into Back Creek, a tributary of Elk River, which in turn debouches into the bay.

The route passes through a rich agricultural country, and the channel is far from being a contracted ditch, such as the name canal generally suggests. With the exception of the pass through the defile of the Deep Cut, it is a succession of pools and broad streams, varying in width from a few hundred feet to nearly a quarter of a mile, and for a large part of the distance the tow-path does not conform to the sinuous banks, but winds gracefully along an embankment placed in mid-stream. These features are mentioned because they are peculiar to this line, and form exceptionally favorable conditions in the project of enlargement.

For 63 years this waterway has continued to perform a valuable service, but in the race for supremacy, and the expansion which has taken place in the capacity of vessels, it has gradually fallen to the rear, until now it may be said to be antiquated and unable to fulfill the purpose of its builders. . . .

In every engineering enterprise it is important to sit down first and count the *cost* as well as the revenue.

This has been done on the part of the Government, and it is estimated at over $7,000,000; but of this amount $3,249,664 was for dredging in the approaches, and $4,355,808 was for the canal 100 ft. wide, its locks, bridges and other works, including land damages. These dimensions are, however, unnecessarily wide for the present, especially in view of the shortness of the Deep Cut. There is no need of a double track through these four miles, and hence a smaller section would prove just as effective and much cheaper. The Suez Canal is but 72 ft. wide at bottom, and the Amsterdam 86 ft., while the Sault, which to-day outranks in tonnage any canal in the world, was only 64 ft. wide and 13 ft. deep up to the date of its enlargement, which was completed in 1882. The present dimensions are 108 ft. wide at the narrowest part, increasing to 500 just above the lock, and 16 ft. deep, the section being rectangular.

By a reduction of width to a limit sufficient to pass the largest ocean-going vessels in single file, the cost of construction may be kept within $3,000,000 for the 14-mile canal, while the revenue would be derived from the entire foreign commerce of Baltimore going to Northern and Eastern ports, which is 90 per cent. of the total, and a large local and coastwise tonnage, all of which aggregate for the two bays, 27,000,000 tons. Of this amount 20 per cent. would no doubt traverse the canal. This at the low rate of 15 cents per ton would produce a revenue of $810,000. After deducting expenses it should leave not less than 15 per cent. for dividends and interest on the capital.

As the economic value of a waterway is dependent upon the ratio of its length (and hence its cost) to the distance saved, it will be seen by comparison that there are only two canals in the world which surpass this one in this particular—they are the Suez and the proposed Nicaragua. The Suez Canal, 100 miles long, saves 3,750 miles. Its length is therefore nearly 3 per cent. of the distance saved. The Nicaragua, 169 miles long, is less than 2 per cent. of the 10,000 miles which it would save.

The Chesapeake & Delaware is but 4 per cent. of its greatest saving.

The North Sea & Baltic, 61 miles long, is 27 per cent. of distance saved.

The length of the Florida Ship Canal would equal 29 per cent. of the distance cut off, but as it would be 169 miles long and transit through it would be slow, the economy in time would be only 12 hours between New York and New Orleans.

The length of the Amsterdam Canal is 42 per cent. of the former route.

In short, it would seem that there are but few if any places on the face of the globe where so small an expenditure of capital gives promise of such large and immediate returns, where there is so large a commerce in sight in the adjacent and tributary waters, where the benefits to the overland lines of transportation will be so great and where the work will be of the utmost practical utility to the Government in increasing the efficiency of its naval

force in time of war, and a potent factor in removing cause for war with any foreign power in times of peace.

In fact its construction becomes a matter of necessity if we hope to keep pace with and aid in the symmetrical development of the commercial interests of our country as a whole.

THE BERLIN UNDERGROUND RAILROAD.

THE building of an underground electric railroad in Berlin has been for some time under discussion, and plans for its construction and the operation of the trains by electricity have been submitted by the Allgemeine Elektricitats Gesellschaft. The sketch map, fig. 5, shows in outline the roads to be built, the solid lines showing those first required. These consist of a circle or ring line, intersected by two long cross-lines with terminal loops. The latter connect with the railroads entering the city.

An outer circle, to be added later, is shown by the dotted lines.

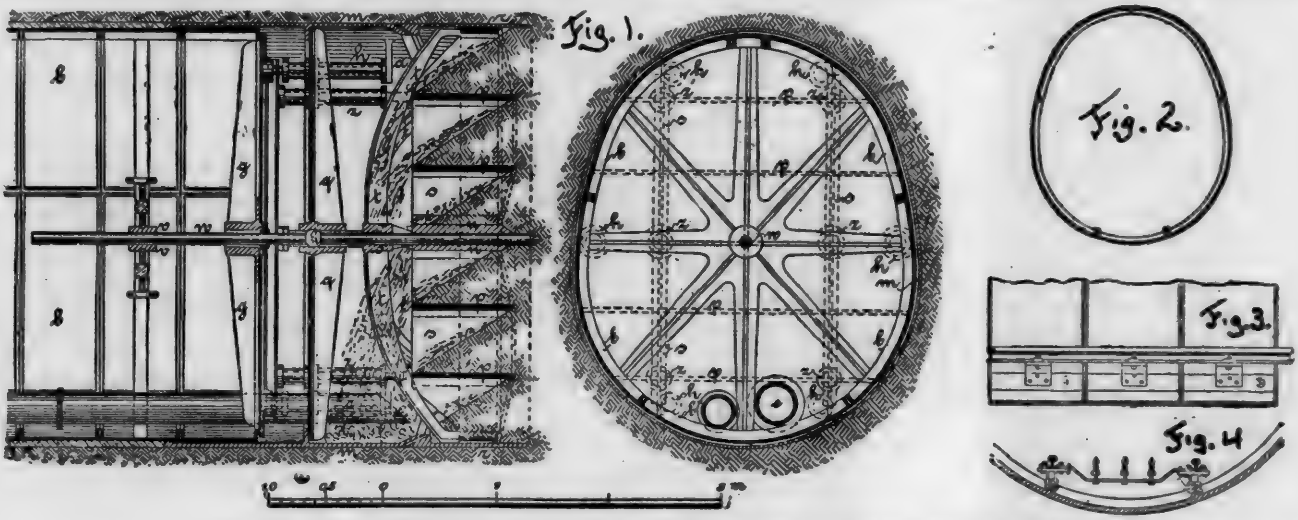
Berlin already has an outer circle or line around the city, known as the Ringbahn. This is a surface line connecting the roads entering the city, but it is too far out to serve for city travel. From Charlottenberg a cross-line extends from this road to the opposite side of the city near the Spree. The cross-line is partly a surface road, but through the built-up portion of the city it is elevated on masonry arches.* The Ringbahn and the Stadtbahn,

as the cross-line is called, are shown on the map by the heavy dotted lines. The Stadtbahn carries many passengers, but serves only a small part of the city.

The method proposed for building the tunnel is indicated in fig. 1, and is similar to the Greathead method used in building the City & South London road in London. In this method an iron shield, fitted with projecting cutters or scoops, is pushed forward by means of hydraulic rams into the soft gravel and sand which constitute the subsoil, and, with the help of water led into the excavating chamber through pipes, the combined water and sand, forming a mud or sludge, is drawn out through a large pipe by suction and discharged into suitable receptacles at the tunnel entrance. Following upon the progress of the iron shield, the cast-iron lining of the tunnel is built up, each section being composed of five segments jointed by bolts through flanges. Hydraulic cement is forced by air pressure into the space surrounding the sections as built up, thus forming a grouted exterior lining.

The tunnel proposed is only large enough to carry a single track, so that as many tunnels must be built as tracks are required.

Fig. 2 is a section showing the section of the tunnel, its general form, and the manner in which the cast-iron shell is built up. Figs. 3 and 4 give, on a larger scale, the bottom flanges in section, showing the way in which the rails are to be mounted and the cross-ties on which will be mounted the insulators carrying the power wires.



DESIGN FOR UNDERGROUND RAILROAD IN BERLIN, GERMANY.

It is said that these plans will probably be adopted, and that the work will be begun before long. The additional facilities are very much needed in Berlin, where a large and rapidly increasing population is crowded into very close quarters on account of the difficulty in reaching the suburbs.

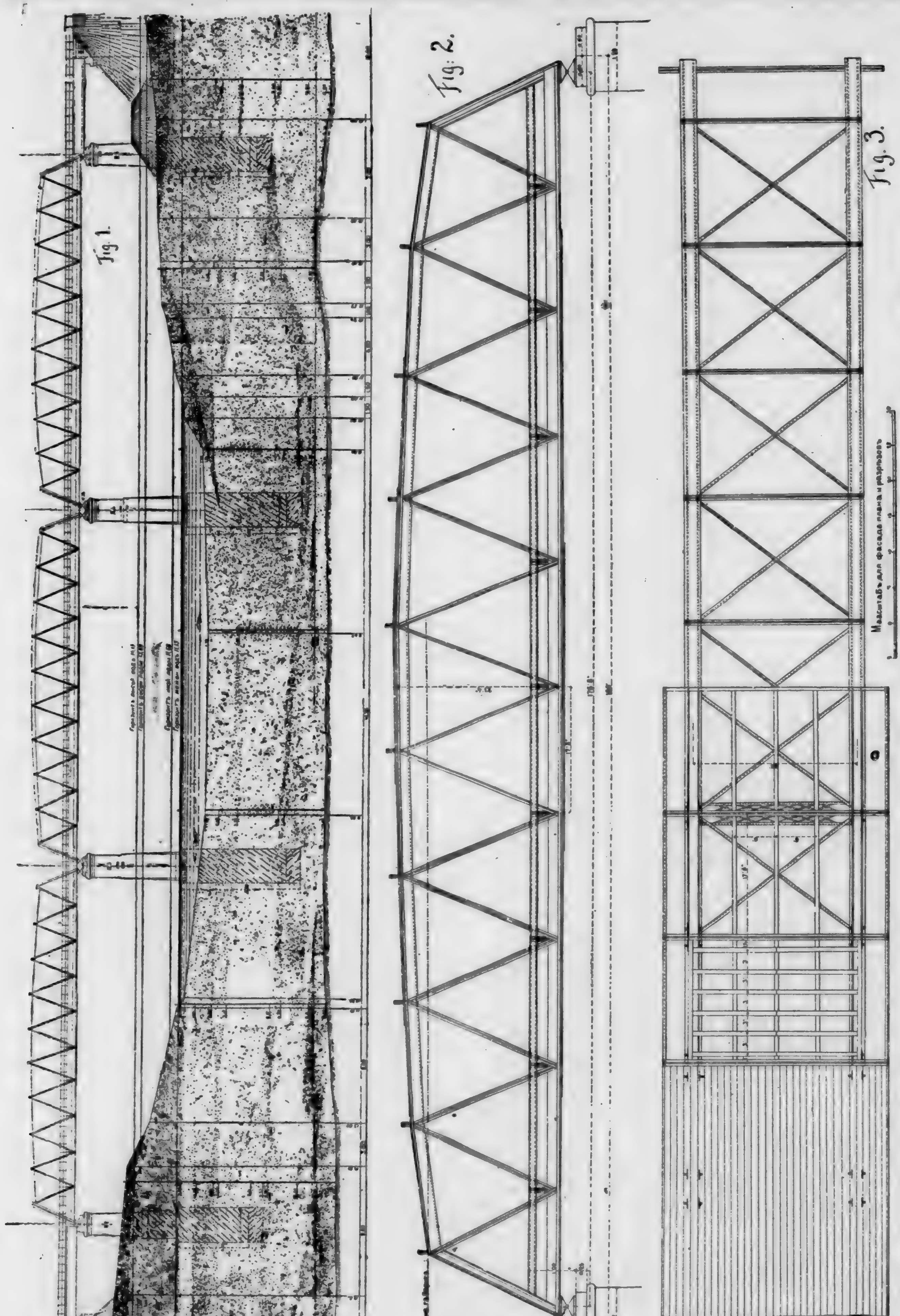
HIGHWAYS VERSUS RAILROADS.

(Professor N. S. Shaler in the *Atlantic Monthly*.)

JUDGED by the standard of our local ways, America as a whole must be regarded as the least advanced of all countries which are commonly classed as civilized. It is true that our great transportation routes, those which are plowed by the steamers of our inland waters and traversed by locomotives, are well organized, wide-spreading, and efficient in a high degree; but these ways serve in a direct manner only a narrow belt of country on either hand. They have a high interstate and international value, but little relation to the needs of local life. So far from meeting the necessities of rural neighborhoods or aiding in their development, they have tended to retard the growth of the less conspicuous but really more important channels of communication, our common country roads.

A very strong argument could be made to support the point that the United States would have been in all essential regards more prosperous than it is at present if, in place of its railroads, it had secured a system of highways constructed and maintained in the highest state of the road-maker's art. It is true that our export industries would have been much less important than they are now. It is true also that a prosperity in manufacturing which has brought great bodies of our people to the Birmingham state of hived employment would not exist. Many

* This road was described in the JOURNAL for May, 1887.



BRIDGE OVER THE RIVER NIEMEN AT OLITA, RUSSIA; DESIGNED BY PROFESSOR N. A. BELELUBSKI.

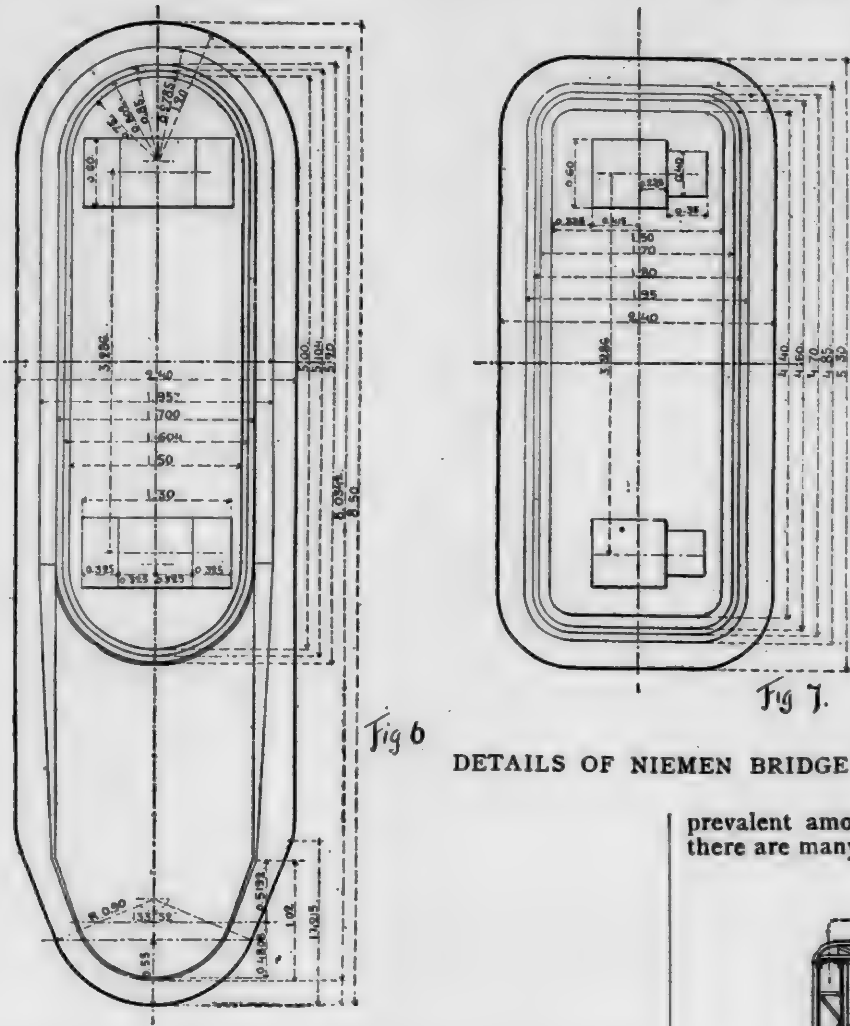


Fig 6 Fig 7.

DETAILS OF NIEMEN BRIDGE.

of our cities would be but country towns, and the buffalo would still roam over much of the country to the west of the Mississippi. On the other hand, our farmers would know more of one another than they do at present. Though they could not market their corn in Liverpool, they would still be able to take it to mill without the sore tax which the bad roads so generally levy upon them, or which the toll-taker requires as the price of a passable way. In such a well-united community, distance counts for little against the duties of life, or against those pleasures which are in the higher sense a part of human obligation. The farmers could attend their town meetings, if they were so fortunate as to live in a part of the world which is governed by local parliaments. They could do their duty by the churches, and have a share in the festivities which enliven and enlarge their days. On the contrary, where the roads are bad, all the duties of the citizen and the social being are most imperfectly done. The people get in the habit of a hermit life; the winter season, which should be the season of social intercourse, is passed in seclusion; households have but little touch with one another, and any real communal life becomes impossible.

A RUSSIAN HIGHWAY BRIDGE.

THE drawings given herewith show a highway bridge over the River Niemen, near Olita, in Russia, on the line of the great national road known as the Strategic Road. This bridge was recently completed, having been formally opened for travel in October.

As shown in the general elevation, the bridge consists of five spans supported by two abutments and four piers of masonry. At each end there is a short plate-girder span, 44 ft. in length; the three remaining spans are of equal length, each being 25.7 sagènes (176 ft. 8 in.) long. The distance between the centers of the piers is 180 ft. The main roadway is 21 ft. wide in the clear between the trusses, and there is on each side, outside the trusses, a footwalk 3 ft. 6 in. wide.

In the drawings, fig. 1, as above stated, gives a general elevation of the bridge, showing all the spans. Fig. 2 is an elevation, and fig. 3 a plan of one of the long spans; fig. 4 is a cross-section and fig. 5 an end view of the span; fig. 6 is a plan of one of the river piers and fig. 7 a plan of one of the shore piers.

The general design of the long spans, the method of bracing and the floor system are so clearly shown that but little description is needed. The bridge superstructure is entirely of iron. The dimensions in fig. 1 are in Russian sagènes, but in figs. 2–5 they are given in English feet.

The foundations of the two river piers are carried down to a depth of about 60 ft. below the river-bed. The subsoil is chiefly sand, gravel and bowlders, with some layers of clay, and the bed-rock is about 70 ft. below the river-bed. A substantial foundation was obtained, however, without going down to that depth.

The bridge is an example of the latest and most approved practice in Russia, and is interesting as showing the ideas prevalent among the engineers in that country, where there are many points of similarity to our own.

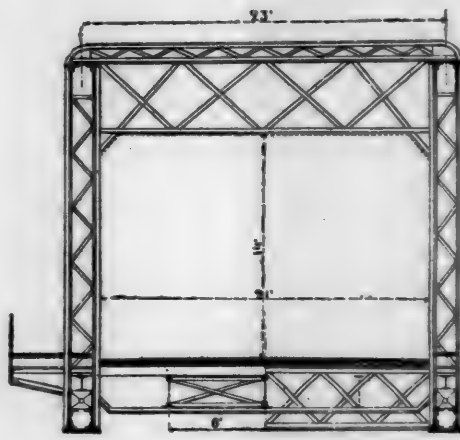


Fig. 4.

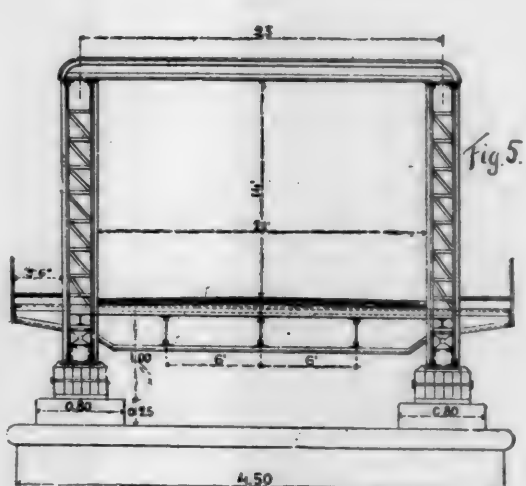


Fig. 5.

The designer of this bridge was Professor N. Belelubski, Chief of the Russian Imperial Institute of Engineers, and Director of the physical laboratory maintained by the Government. Professor Belelubski is Consulting Engineer to the State Department of Roads and Communications, and has designed a number of important structures, including the great bridges over the Volga, the Dnieper and other rivers. He has recently received a notable honor, the number of the *Annals* of the Imperial Institute issued on the twenty-fifth anniversary of its organization being chiefly devoted to an account of his work. It may be added that the designs of the numerous bridges required for the Siberian Railroad will be made under his supervision.

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INCONVENIENT AND UNCOMFORTABLE LOCOMOTIVES.

(From *Locomotive Engineering*.)

THE designers of locomotives intended for service on railroads that have numerous curves ought to take into consideration the importance and necessity of the engineer seeing ahead when the engine is rounding a curve. We have enjoyed the best of opportunities for observing the limited outlook from the cabs of a great many locomotives employed on very crooked roads, where cuttings are numerous, and the impression received is that the practice is becoming general of making a solid line of obstructions from the cab to the smoke-stack. The cabs are now so placed that an engineer cannot step to the left-hand side to see that all is clear when he is rounding a curve; the duties of the fireman are too arduous to give him any time for keeping a systematic lookout on curves, and so the practice is for the engine to rush along blindly, depending on the good fortune of finding a clear track. We have heard of more than one instance where tail-end collisions have happened that could be directly traced to the engineer not being able to see ahead in rounding a curve. There is a growing sentiment among railroad commissioners to require a third man to be carried on locomotives where the fireman is so located that he cannot keep a lookout ahead. When juries begin to find out that accidents are happening through the engineer b ing unable to see the reach of the track visible on curves, they will stimulate public sentiment to demand the presence of more eyes on the monster locomotives that are becoming the rule as train haulers. The proper way to stave off this source of expense is the devoting attention to opening the view for the engineer across the boiler. This can be helped materially by a little attention to the locating of dome and sandbox.

Another thing that demands attention is the location and width of the cab. Many cabs are made as if they were intended for liliputians, a man of moderate size having to squeeze himself to get in position to reach the working levers. This may be quite comfortable as viewed from the drawing office, and it entails no great hardship upon the man who goes in inspecting the arrangement when the engine is cold in the builder's shop. On the road it is a different matter. With hot weather and the intimate proximity to a hot boiler, the man in the cab is parboiled during a great part of the time he is at work. Is it surprising that the man who is subjected to this ordeal, day after day, gets convinced that engineers are a poorly paid class considering the discomforts they have to endure? A very little forethought and no extra expense would make the cab comfortable. Apart from humanitarian considerations we believe that it would pay railroad companies to effect a reform in the locomotive cabs.

A SWISS COMPOUND LOCOMOTIVE.

THE accompanying illustration, from *Industries*, shows a compound locomotive for passenger service recently built for the Jura-Simplon Railroad in Switzerland by the Swiss Locomotive & Machine Works at Winterthür. The road has a large passenger traffic in summer and the heaviest of this has to be worked over several sections with heavy grades and many sharp curves.

The standard locomotive which the Jura Simplon Company has adopted for this work is of the American type, with four driving-wheels and a four-wheel truck. The company has already in freight service a number of compound engines of the Mallet two-cylinder type. For passenger service the locomotive shown is a new departure; it is a two-cylinder engine, but has a starting-valve of the Von Borries type, which admits steam from the boiler di-

rectly into the low-pressure cylinder, but closes automatically and begins the compound working without the action of the engine-driver.

The high-pressure cylinder of this engine is 17.69×25.57 in. and the low-pressure 26.38×25.57 in., the proportion of the cylinders being 1 : 2.2. The steam-chests are placed above the cylinders, and the valve-motion for both cylinders is of the ordinary shifting link type. The valve-rods are worked from rocker arms, and the valves are of the Allen pattern. The reversing gear is moved by a screw and hand-wheel.

The frames are of steel plate 1 in. thick, and the cross-bracing is unusually strong and stiff. The steam reservoir between the two cylinders is in the smoke-box, and consists of a pipe of an arched form; the steam-pipes from the boiler are also placed in the smoke-box.

The driving-wheels are 72.13 in. in diameter, one pair being in front and one back of the fire-box. The driving-axles are 8 ft. 6.31 in. apart between centers, and the distance from center of forward driver to center of truck is 11 ft. 1.19 in.

The truck is of the swing-bolster pattern, with plate frame. The truck wheels are 40.5 in. in diameter, and the truck axles are 7 ft. 2.58 in. apart between centers. The truck frames are of steel, and that material has been used wherever possible in the engine. The crossheads are of cast steel.

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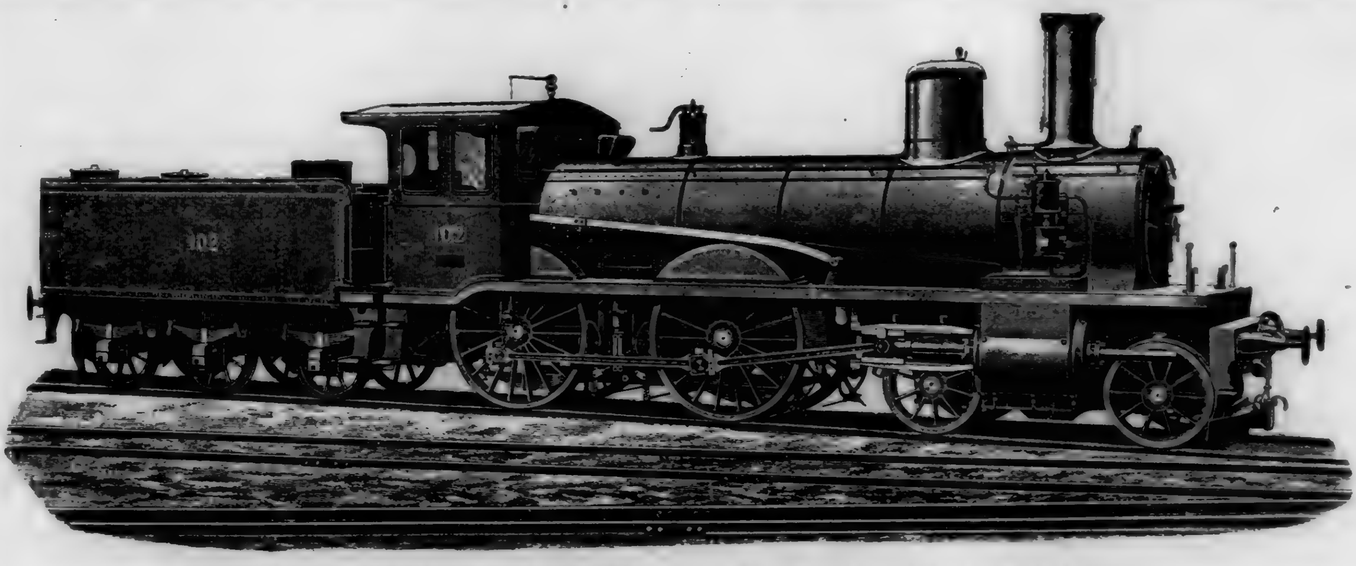
The total length of the engine over all is 32 ft. 2 in. Its weight in working order is 105,950 lbs., of which 63,600 lbs. are carried on the drivers and 42,350 lbs. on the truck. The tender weighs 66,750 lbs., and has a total length of 19 ft. 3 in.

The tender is carried on six wheels 40.5 in. in diameter. The frame is of steel plate. The tank has a capacity of 3,640 gallons of water, and the coal box will hold about 9,000 lbs. of coal.

On the trial trip this engine took a train weighing 257 tons, including weight of engine and tender, up a long 1 per cent. grade, maintaining a uniform speed of 30 miles an hour, with an abundant supply of steam.

The engine is fitted with Haushalter's recording speed indicator, driven from the right-hand coupling-pin, and with Gresham's steam sanding apparatus, fed from sand-boxes beneath the foot-plate, while an apparatus is supplied for washing the rails in the numerous tunnels occurring on the line, especially in the Jura sections. It is equipped with the latest quick-acting Westinghouse brake, the air-pump being placed, as will be noticed, on the smoke-box. On the engine both driving wheels are acted upon by the usual toggle-joint apparatus, in connection with a 6-in. brake cylinder on each side. The tender has brake-blocks on each side of the wheels of the leading and trailing axles.



COMPOUND EXPRESS LOCOMOTIVE FOR THE JURA-SIMPLON RAILROAD

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THERE has just been completed in Norway a work of which very little has been heard in this country, but which has many most interesting and difficult engineering features, and which is likely to have most important results on the commerce and industry of that country. There has been constructed a magnificent canal, or, more properly speaking, a series of locks and weirs, by which a large and rapid river has been canalized and transformed into a useful water highway, thus opening out a large part of the great watershed of Thelemarken, and placing the heart of southern Norway in direct communication with the sea.

We will content ourselves for the present with a brief outline of this scheme, and a few remarks on its commercial aspects. About midway between Christiania and Christiansund there is the port of Langesund at the mouth of a fjord leading to the ports of Porsgrund and Skien, the latter being about 17 miles inland and connected with the large Nordsjo Lake by a short stretch of river. About half-way up this lake there is the village of Ulefos, the seat of an important iron industry. This lake is joined by a river to a chain of lakes consisting of Flauvand, Hoiteseidvard, and Bandakvard, all coming generally under the latter appellation, and forming the receptacles for the water collected from an immense watershed. The problem which had to be solved was the canalization of the connecting rivers and the lakes so as to afford a continuous outlet from the center of the country to the sea. This was a work of considerable difficulty on account of the differences of level, and the consequent magnitude of some of the constructions required. For instance, at Ulefos, where the canalizing of the river commences, there is a set of three locks and an aqueduct, by which the canal is carried for some distance past a weir and waterfall 36 ft. in height. Two miles further up there are two more locks, which are cut out of the solid granite, and which enable vessels to enter the river again a short way above the Eidsfos—a fall of 33 ft.

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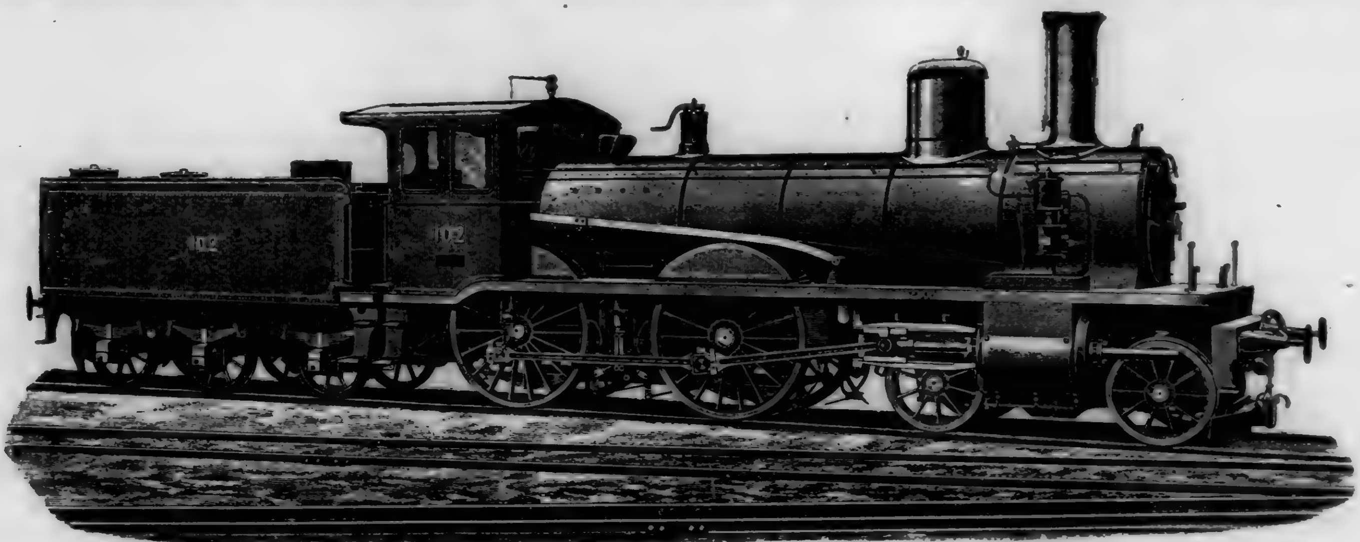

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were thereby converted into a perpendicular fall of water, a piece of construction which required very great care. A series of smaller locks completes what is necessary to open the navigation to the Bandak Lake, and, so far as can be seen, the whole work has been judiciously planned and carefully carried out. The cost of the undertaking was about $780,000, but a considerable sum will still be required for dredging and the formation of dykes. The total length of the canal from Ulefos to Strengen is nearly 14 miles, and the principal dimensions of the locks are as follows: Length, 124 ft. 8 in.; breadth, 26 ft.; and minimum depth on sills, 9 ft. 3 in.

The great Lake Nordsjo, from which the canal starts, was connected with the sea so far back as 1861, by means of two locks at the town of Skien, and four other locks between that and the lake, so that the work which has now been carried out is a completion of an undertaking commenced more than 30 years ago. The series of lakes thus connected open up a very large district to direct connection with the sea, and thus afford very great facilities for the development of trade and industry, which is likely to have a most important effect on the welfare of the country. The importance of the work is duly recognized in Norway, and a ceremony was held August 20 last, which was attended by the Government authorities and other officials, to celebrate the completion of this great national undertaking.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(Continued from page 512.)

About the year 1875 paragraphs were floating in the American newspapers concerning the "California flying machine," which was said to be under construction in San Francisco. This was the design of Mr. *Marriott*, of the San Francisco *Newsletter*, formerly a fellow-worker with Mr. *Stringfellow* in aeronautical pursuits, and also a resident of Chard.

Mr. *Marriott* had already experimented in 1867-69 with an elongated balloon, provided with attached aeroplanes, from which he expected to obtain additional sustaining power when at speed—a system which has been many times proposed, and which is often brought forward again by inventors who are not aware of the prior experiments.

Mr. *Marriott's* balloon model was 28 ft. long, 9½ ft. in diameter, with aeroplanes extending for half its length, and was to be driven by a light steam-engine, rotating a propeller 4 ft. in diameter 120 times a minute. The utmost speed that could be obtained was five miles per hour, and as this was not sufficient to stem the winds that constantly prevail in San Francisco, the inventor turned his attention to a design for an aeroplane.

This is said, in the report of the Aeronautical Society of Great Britain for 1875, to have consisted of three planes, superposed longitudinally, with an interval between them of about 10 ft. In transverse length the whole structure was to be 120 ft. fixed upon a foundation of trussed bamboo, the planes being unequal in size, the largest on the top being of the above dimensions and about 40 ft. wide, the three planes being rigidly supported by two masts about 40 ft. high and stayed by wire rigging.

To the lower end of each mast were to be affixed small wheels, to run down an inclined rail, in order to impart the necessary initial velocity to the apparatus, and this impulse was then to be continued by means of a steam-engine enclosed in a square compartment capable of holding the engineers. This compartment was to be located in the center of the trussed bamboo keel. The engine was to work four screw propellers, two of them vertical and two horizontal, their place of working breaking up the continuity of the longitudinal planes. The weight of the whole machine was estimated at 1,500 lbs., including the motive power and the engineer.

No drawings or detailed description of this aeroplane were ever published, the inventor's idea being to keep his plans secret until he had made a success of the machine. It was never completed, for Mr. *Marriott* sickened and died before the apparatus was ready for trial, and his associates did not care to risk the great outlay which would have been necessary to test so large and expensive an apparatus. The weight of the motor and the equilibrium would have been the stumbling-blocks.

At the meeting of the Aeronautical Society of Great Britain for 1876, M. *Sénécal* gave some notes on the stability of aeroplanes of different forms, which he illustrated with paper models, and these experiments are so easily reproduced that the following account of them, quoted from the report, will probably prove interesting:

He said that while planes of even width and thickness (load uniformly distributed) revolve upon their own axes, and their path of translation is rectilinear, the motions of triangular planes are much more complicated. These planes are obtained by dividing the circumference into blades of different widths. These blades, besides revolving upon their axis, rotate also round a vertical conic axis, whose base is upward, the vertex of the plane describing a spiral round the conical axis.

He found that the rate of revolution and rotation increases in direct proportion as the base and the length of the blade decreases, and the length traveled over in a unit of time decreases also in the same proportion. The shifting of the center of gravity (pressure ?) of these blades is most interesting. It was found that the center of gravity of narrow planes was near the vertex and on the edge of the plane, but recedes toward the base and axis as it widens; it also travels from the axis toward the edge and vertex as the rate of revolution increases, and possibly that, at high velocities of rotation, the center of gravity will be beyond the edge. The size of blade that revolves and rotates most steadily represents the eighteenth to the twenty-fourth part of the circumference. He also proved that by cutting a small plane out of the base it had the same effect as applying a weight at that point before cutting it. The plane will then revolve and rotate round with its base turned toward the vertical axis.

He also liberated several narrow strips of paper, showing, while revolving, nodal and ventral sections similar to musical strings in vibration, the number of aliquot parts increasing with the length of the ribbons and disappearing as the width increases.

M *Sénécal* then enunciated the following law: that planes, of whatever form, but of even thickness and rigid margin, in order to translate steadily must carry their maximum load on a line representing the first third part from the anterior margins of the plane; but one can, with impunity, apply graduated weights from that line right on to the edge, and, in some instances, a good distance beyond the edge, and high rate of speed is the result. The rate of translation increases directly with the load placed on the different points of the graduations from that line of the center of gravity.

While the account of the action of these paper planes is not very clear, it is sufficiently so to permit the curious in such matters to repeat the experiments, and these will be found more instructive than any description of the results, however accurately expressed. The action will be found to be greatly modified by slightly folding the back edges as already described.

In 1877 Mr. *Barnett*, of Keokuk, Ia., patented in the United States a flying machine somewhat similar in arrangement and principle with that of *Pénaud* and *Gauchot*. It consisted in an aeroplane something like a boy's triangular kite, but with the two longitudinal halves set at a diedral angle from the central spine or spar, in order to obtain lateral stability. Just under this kite a boat-shaped car was to be affixed, carrying the motor, which was to rotate two propellers mounted upon shafts at the front of the apparatus, and turning in opposite directions. An adjustable tail was to carry part of the weight and to regulate the angle of incidence, the car being provided with wheels so as to run over the ground until the speed was great enough to give a sustaining reaction.

This design is not without merit, but it leaves unsolved the two principal problems concerning aeroplanes—*i.e.*, the providing a light motive power, which shall not weigh more in proportion than that of the birds in ordinary flight, say 20 lbs per horse power, and the providing for automatic stability, which, as already explained, should be greater for an inanimate machine than for a live bird. The form of the triangular kite is not stable, as many a boy has found out to his sorrow by providing an insufficient tail, and if the kite form is to be used, it will proba-

bly be best to experiment with shapes that fly without a tail, some of which will be noticed hereafter.

Mr. *Barnett* is understood to have tried many experiments, extending over a period of 30 years. He first constructed a plain flat kite some 12 ft. long and 10 ft. wide, under which was hung a frame so as to attach and adjust the mechanism for turning two propellers rotating in opposite directions. This machine was not placed on wheels, but he was much pleased with the clutch that the propellers took on the air. Next he constructed an apparatus to carry the weight of a man. This consisted of a kite or aeroplane of canvas 27 ft. square, from which hung a propelling arrangement somewhat similar to that shown by Mr. *Maxim* in the *Century Magazine* for October, 1891, as the manner of connecting the aeroplanes and attaching the screws in his experimental apparatus. This machine was placed on wheels, being the running gear of a light spring wagon, and as Mr. *Barnett* knew of no motor sufficiently light for actual flight, he determined first to experiment with his own muscular power.

The propellers were two bladed, each blade being of oil-cloth and a sector of a circle, or like a piece from the ordinary round pie. The operator was beneath and rotated them through appropriate gearing. He ran the machine along smooth country roads, but as soon as speed was gained, the increasing air pressure, acting forward of the center of figure, in accordance with the law of *Joëssel*, already given, would tip up the front of the aeroplane and disturb the equilibrium. This led the inventor to believe that the propellers were too far below the aeroplane, and he altered their position, but without any better result; the machine would still tip backward, presenting a greater angle of incidence, and increasing the resistance. Moreover, it would not keep to the line of the road, but, as it was propelled, would run off to either side into the grass, weeds or uneven ground, swerving in a way which would have involved great danger if it had been able to rise into the air.

Picking out a quiet evening, near dusk, the inventor determined to give it an extra good test over smooth ground, and while apprehensive that if it left the earth it might lurch and come to grief, he managed by "main strength and awkwardness" to get under considerable headway, when the front end tipped up so much as to break and splinter the main support, and the inventor came very near getting hurt.

This terminated the experiments with that machine. Subsequently the inventor entered it for exhibition at the State fair as an "automatic kite," and he says quaintly that he entered, at the same time, some samples of tomatoes, cabbage and grapes of his own growing; received a premium on the tomatoes and cabbage, and favorable mention on the grapes, but concluded at the last moment not to take the "kite" to the fair ground, as it did not perform as he desired.

He has built two more machines of such dimensions as to support a man within the last six or seven years, and has tested them upon a smooth pasture, but found this, after many weeks of trial, too rough and uneven for his purpose. The tracks of animals, a bunch of grass, or a corncob would check the speed, so that with all his strength he could not arrive at sufficient velocity to leave the ground. This is not surprising, for Professor *Langley* has since shown that the best that can be done with a plane is to sustain 209 lbs. by the exertion of one horse power, and this without any hull resistance whatever, so that, as man cannot steadily exert much more than one-tenth of this power, a total weight of about 20 lbs. is the maximum that he can hope to support and drive through the air by the exertion of his own unaided strength.

Mr. *Barnett* has of course experimented with a considerable number of small models. He first tried clock springs, but found them too heavy; and all would-be inventors had better avoid wasting effort with them; next he tried twisted india-rubber, and while he found great irregularity in its action, he succeeded in obtaining a number of fair flights among many failures. He experimented with superposed planes, but the result was not satisfactory. His last model, produced in 1892, resembles his original design, and, driven by rubber bands, succeeded in getting a preliminary start by running over a platform 12 ft. long, slightly inclined, and flying through the air "above the hollyhocks and other flowers" until it struck the side of a house 30 ft. away, and 4 ft. higher than the platform.

India-rubber is a good reservoir of power to experiment with. The flights are brief, as the power is soon spent, but they give an opportunity of testing the equilibrium, the proportions, and the adjustment of the parts, which may suggest themselves to an experimenter as possibly efficient.

An apparatus patented in France by M. *Pomès*, in 1878, is represented in fig. 57. It consisted in two supporting planes in front, together with a keel plane, and a large

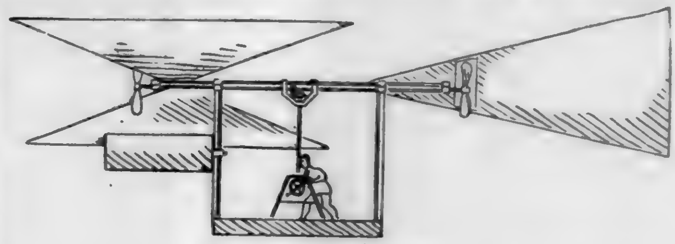

Fig. 57.—POMÈS—1878.

vane behind, to maintain the course. Two propelling screws on the same horizontal shaft were to impart motion, and although they are shown as actuated by hand on the figure, the same inventor had already patented, in 1871, in connection with M. *de la Panze*, a gunpowder motor, in which a series of charges, exploded by electricity, were made to pass through a tube and to impinge against the buckets of a revolving wheel, from which the motion was to be communicated to the propellers. Neither this motor nor the aeroplane possess merit, and indeed the latter is about as badly arranged as it can be, for as the air pressures which are to sustain the weight act with a leverage increasing toward the tips of the wings, or sustaining planes, the latter should taper in plan from the center of the apparatus outward, instead of tapering inward as shown in the figure, in order to obtain a light and strong construction. It is not known whether M. *Pomès* experimented at all, but if he did, it must have been with very small models, for his design is quite unsuitable for a large one, and has been here included in order to point out the deficiencies of such a design.

In 1878 Mr. *Linfield* constructed an apparatus to test *his* conception of an aeroplane. It consisted of plane surfaces extended on a framework 40 ft. $\times$ 18 ft. at its greatest width, and measuring about 300 sq. ft. in surface, the weight of the apparatus being 189 lbs. It was mounted upon wheels, and driven over a macadamized road by the action of a screw propeller placed in front of the machine, rotated at about 75 revolutions per minute by the aviator, working a treadle and levers with cross handles. Upon the highway, on an incline of about one in a hundred, a speed of 12 miles an hour was attained without any indication of a rise from the ground. Then by going down hill, a speed of 20 miles per hour was obtained, but still without perceptible effect, which is not be wondered at, for at this speed, with an angle of incidence presumed to have been 6°, the "lift" would be $300 \times 2 \times 0.206$, or, say, 123 lbs., while the weight including the aviator was over 300 lbs. It would have required an angle of 17°, at a speed of 20 miles per hour, to have produced sufficient "lift," while at that angle the "drift" alone would have required the exertion of 5 horse power, which the operator was clearly unable to furnish, it being "most dreadful exertion" to work the treadles at the flatter angle of incidence above presumed to have been experimented.

Subsequently Mr. *Linfield* built another machine upon a different principle. It was 20 ft. 9 in. in length, 15 ft. in width, and 8 ft. 3 in. high; the sustaining surfaces being in two frames, each 5 ft. square. Each frame contained 25 superposed planes of strained and varnished linen 18 in. wide and spaced 2 in. apart, thus somewhat resembling a cupboard without front or back, and with shelves very close together. These frames were slung on either side of a cigar-shaped car at its maximum section, being

set at a diedral angle to each other, so that the apparatus, could it have been seen in the air, would have resembled a huge cigar with a pair of saddle bags attached thereto. There was a nine-bladed screw at the front, and a guiding vane, like the tail of a dart, behind ; the entire sustaining surfaces in the two frames being estimated to aggregate 438 sq. ft., and the whole machine, which was mounted on four wheels, weighing 240 lbs., to which 180 lbs. must be added for the operator, thus providing a little over one square foot of sustaining surface per pound.

Mr. *Linfield* was to stand between the two front wheels and actuate two treadles to rotate the screw, which was 7 ft. in diameter ; but when the time arrived for testing the machine upon an ordinary macadamized road, it was stated that this could not be done on account of the impossibility of blocking the road during the trial. This was in a measure fortunate, for it led Mr. *Linfield* then to arrange with a railway to mount the machine on a flat car and to tow it behind a locomotive. When a speed of 40 miles per hour was attained the machine rose entirely free from the car, but was not allowed to swerve very far, as there was a side wind blowing, and it swung very close to the telegraph poles as it was. The tow line was some 15 ft. long, and the pull thereon was 24 lbs., which for a 240-lb. machine (without the aviator) indicates an angle of incidence of 1 in 10, or 6°. At this angle, and at a speed of 40 miles per hour, at which the air pressure would be 8 lbs. to the square foot, the total lift for a single plane ought to be $438 \times 8 \times 0.206 = 722$ lbs., so that, if the 240 lbs. of machine was just sustained, it indicates that the very narrow spacing (2 in.) between the superposed aeroplanes greatly interfered with their efficiency.

Mr. *Linfield* also tested the efficiency of superposed screws. He placed nine of them some 6 in. apart upon a vertical shaft. These were all with two narrow blades and 3 ft. in diameter, but in whatever relative position they were placed radially, he could get no greater lift from the nine screws than he could from the top and bottom screws only, 4 ft. apart, the seven intermediate screws being removed.

The idea of testing the apparatus by towing it on a railway car was evidently a good one, but this disclosed such inefficiency of lifting power and of stability as to put an end to the experiments.

We next come to a series of very careful experiments, tried by an able mechanician, which almost demonstrate that artificial flight is accessible to man, with motors that have been developed within the last two years. These experiments were carried on by M. *V. Tatin*, who was then Professor *Marey's* mechanical assistant. He first began with beating wings, and produced, in 1876, the artificial bird which has already been briefly noticed under the head of "Wings and Parachutes." This was driven by twisted rubber ; not only did M. *Tatin* find that the power required was unduly great, but he also found that this power could not be accurately measured, the torsion of india-rubber being erratic and stretching unequally. He constructed a large number of mechanical birds of all sizes and various weights ; he tried many modifications and entire or partial reconstructions, and finally concluded, after spending a good deal of time and money, to take up the aeroplane type, to be driven by a reservoir of compressed air. With this his efforts were successful almost from the first, and he produced in 1879 the apparatus shown in fig. 58, which is practically the first that has risen into the air by a preliminary run over the ground. This machine consisted in a silk aeroplane, measuring 7.53 sq. ft. in surface, being 6.23 ft. across and 1.31 ft. wide, mounted in two halves at a very slight diedral angle, on top of a steel tube with conical ends which contained the compressed air. This reservoir was $4\frac{3}{4}$ in. in diameter and $33\frac{1}{2}$ in. long, was tested to a pressure of 20 atmospheres, and worked generally at 7 atmospheres ; its weight was only 1.54 lbs., and its cubical capacity 0.28 cub. ft. From this (the vital feature of the machine) the stored energy was utilized by a small engine, with oscillating cylinder, placed on a thin board on top of the tube, and connected by shafts and gearing to two propellers with four vanes each, located at the front of the aeroplane. These propellers were 1.31 ft. in diameter, and rotated in opposite directions some 25 turns per second, their velocity at the outer end being about 100 ft. per second. The vanes were of thin bent horn set at a pitch of about 1.50 ft., and they towed the apparatus forward instead of pushing it.

A tail of silk fabric 1.97 ft. across at the rear, by a length of 1.97 ft., was set at a slight upward angle and

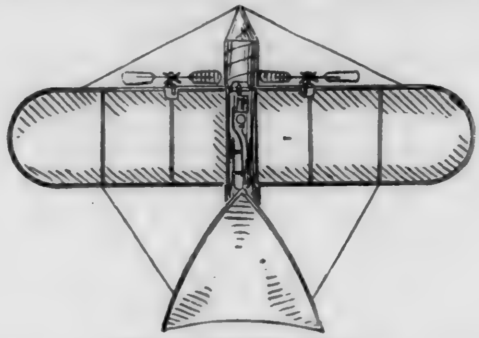

FIG. 58.—TATIN—1879.

braced by wire stays, in order to provide for the longitudinal stability upon the principle advanced by *Pénaud* ; and the whole apparatus was placed on a light running gear consisting first of four wheels, and subsequently of three wheels. The total weight was 3.85 lbs., so that the sustaining surface of the aeroplane (omitting the tail) was at the rate of 1.95 sq. ft. to the pound.

After a vast deal of preliminary testing and adjustment, the apparatus was taken to the French military establishment at Chalais-Meudon, where it was experimented with in 1879 upon a round board platform 46 ft. in diameter. Upon this the machine would be set upon its wheels, the front and rear ends being fastened to two light cords carried to a ring around a central stake, and the compressed air would be turned on to the engine. The propellers would put the apparatus in motion, and it would run from 65 to 165 ft. over the boards, until it attained a velocity of 18 miles per hour, when it would rise into the air, still confined radially by the two cords, and make a flight of about 50 ft., when, the power being exhausted, it would fall to the ground, almost invariably injuring the running gear in doing so.

The flights were not very high, but on one occasion the apparatus passed over the head of a spectator. The angle of incidence was 7° or 8°, and the power developed by the engine was at the rate of 72 33 foot-pounds per second, gross ; but as its efficiency was only 25 to 30 per cent. of the gross power, the effective force was at the rate of 18.08 to 21.70 foot-pounds per second, or, say, at the rate of 5 foot-pounds per second (300 foot-pounds per minute) per pound of apparatus.

This power was measured with great care, the machine being provided with a tiny gauge and tested repeatedly with a dynamometer. M. *Tatin* calls attention to the fact that the minuteness of the engine greatly diminished its efficiency, and that with large machines it would be comparatively easy to obtain 85 per cent. of the gross power developed. He draws the conclusion that his apparatus demonstrates that 110 lbs. can be sustained and driven through the air by the exertion of 1 horse power—a most important conclusion, which will be further discussed hereafter.

To return, however, to the experiments : they are described as follows by M. *Tatin*.*

I will pass without description a series of preliminary experiments which led me to modify certain details, until all conditions were favorable. I then had the satisfaction of seeing the apparatus start at increasing speed, and in a few seconds the carriage barely touches the ground ; then it leaves it entirely at a speed of about 18 miles per hour, which agrees closely with the calculations. It describes over the ground a curve similar to those described by small models gliding freely, and when it comes down after its orbit, the shock is so violent as to injure the running gear. This accident recurred upon each experiment carried out under the same conditions ; the carriage was soon destroyed, and even the propellers were injured, although

* *Aéronaute*, September, 1880.

they could be repaired. I then tried another experiment, which I had already attempted several times without success, in consequence of inadequate preparation. The apparatus, the running gear being removed, was suspended by two grooved wheels running freely over an iron telegraph wire 260 ft. long, stretched as rigidly as practicable. When the speed became sufficient, the apparatus rose, and then one of the propellers struck the iron wire; the front grooved wheel overtook the machine, and the propeller was destroyed. These accidents caused no repining, for they demonstrated that in all cases the apparatus had completely overcome the force of gravity.

In order to continue the experiments I built a new carriage and new propellers, hoping to make them strong enough to stand the shocks during a new set of experiments, from which to deduce accurately the work done. The new running gear had but three wheels, these being larger and lighter than the old. The propellers, on the other hand, were made heavier, but modified so as to rotate more easily. Their vanes were made of a thin sheet of horn bent hot to the proper curvature. The inner two-fifths from the hub consisted of steel wire, this portion of a propeller requiring much force for rotation, and giving out but small effect toward propulsion; but the diameter and the pitch were the same as formerly.

I was, unfortunately, unable to make all the experiments I desired with this repaired apparatus. I intended to study the results with various angles of incidence in the planes and various pitch of the propellers; then to study the important question as to the best proportion between the sustaining surface and the diameter of the propellers; and lastly the speed of translation which will best utilize the force expended.

I was nevertheless enabled to deduce the following figures from my experiments. These figures are not absolutely exact, but sufficiently so to serve as a guide to others who may wish to engage in similar work. Calling A the sustaining surface in square meters (without the tail), and V the speed of translation in meters per second, then we may say:

$$\text{Lift} = O.\ kg.\ .045\ A\ V^2.$$

And the motor will need to develop effective work at the rate of 1.50 kilogrammeters per kilogramme of the weight (4.935 foot-pounds per second per pound), which corresponds to one horse power for each 110 lbs. weight of the apparatus.

These experiments seem to demonstrate that there is no impossibility in the construction of large apparatus for aviation, and that perhaps even now such machines could be practically used in aerial navigation.

Such practical experiments being necessarily very costly, I must, to my great regret, forego their undertaking, and I shall be satisfied if my own labors shall induce others to take up such an enterprise.

The effective work done by this aeroplane having been accurately measured, it affords a good opportunity of testing the method of estimating resistances which has been proposed by the writer in estimating the work done by a pigeon.

The weight of M. *Tatin's* apparatus was 3.85 lbs. Its aeroplane surface was 7.53 sq. ft., the angle of incidence was 8°, and the speed was 18 miles per hour, at which the air pressure would be 1.62 lbs. per sq. ft. Hence we have, by the table of "lift and drift":

$$\text{Lift, } 8° = 7.53 \times 1.62 \times 0.27 = 3.29 \text{ lbs.},$$

which indicates that a small part of the weight was sustained by the tail.

The hull resistances are stated by M. *Tatin* to have been almost equal to that of the plane. These hull resistances would consist of that of the tube, of 0.12 sq. ft. midsection, which, having conical ends and parallel sides, will have a coefficient of about one-third of that of its midsection. The resistance of the wheels and running gear will be slightly greater, but must be guessed at, as the wheels would continue to revolve through inertia and thus increase the resistance.

The front edge of the aeroplane, which was of split reed and about one-eighth of an inch thick, was 6.23 ft. long; but as the back edge of the aeroplane and the side borders of the tail would also produce some air resistance, we may call the edge resistance as equal to 6 ft. in length, by a thickness of 0.01 ft., without any coefficient for roundness. We then have the following estimate of resistances:

RESISTANCE OF TATIN AEROPLANE.

Drift 8°	$- 7.53 \times 1.62 \times 0.0381$	= 0.4648 lbs.
Tube	$- 0.12 \times 1.62 \div 3$	= 0.0648 "
Wheels and gear	— estimated	= 0.1000 "
Edges of wings	$- 6 \times 0.01 \times 1.62$	= 0.0972 "
	Total resistance	= 0.7268 "

and as the speed was 18 miles per hour, or 26.40 ft. per second, we have for the effective power required:

$$\text{Power} = 0.7268 \times 26.4 = 19.19 \text{ foot-pounds per second},$$

which agrees very closely with the 18.08 to 21.70 foot-pounds per second said to have been effectively developed, and is at the rate of 5 foot-pounds per pound of apparatus, or of 110 lbs. of weight per horse power.

This last is the important point. Now that Mr. *Maxim* has produced a steam-engine which, with its boilers, pumps, generators, condensers, and the weight of water in the complete circulation, weighs less than 10 lbs. to the horse power, aviation seems to be practically possible, if only the stability can be secured, and an adequate method of alighting be devised.

(TO BE CONTINUED.)

THE FIRST LIGHTSHIP WITH ELECTRIC LIGHTS.

IN the RAILROAD AND ENGINEERING JOURNAL for August, 1891, pages 361–64, there was given an illustrated description of Lightship No. 51, designed for the United States Lighthouse Board, the first vessel of her class to be supplied with electric lights. The ship has since been built by F. W. Wheeler & Company, at Bay City, Mich., and will soon take her place off Cornfield Point in Long Island Sound. To complete the account of the vessel we give below an account of the lighting plant, for which we are indebted to the courtesy of the *Electrical Engineer*.

LIGHTSHIP NO. 51, WITH ELECTRIC LANTERNS.

Lightship No. 51 has been fitted with a complete electric plant under the direction and at the suggestion of Commander Coffin, and in accordance with the specifications of Major D. P. Heap, U. S. Engineers, Engineer of the Third Lighthouse District.

Commander Coffin and Major Heap have long been firm in the belief that the incandescent electric light was perfectly adaptable to lightships, certain authorities to the contrary notwithstanding, though the white rays of the arc light are said to be more readily absorbed by fog than those of the oil lanterns in general use, the latter having a yellowish tinge that shows in a fog by contrast.

The incandescent light has, therefore, been employed on No. 51, and the utmost care has been taken to foresee

set at a diedral angle to each other, so that the apparatus, could it have been seen in the air, would have resembled a huge cigar with a pair of saddle bags attached thereto. There was a nine-bladed screw at the front, and a guiding vane, like the tail of a dart, behind; the entire sustaining surfaces in the two frames being estimated to aggregate 438 sq. ft., and the whole machine, which was mounted on four wheels, weighing 240 lbs., to which 180 lbs. must be added for the operator, thus providing a little over one square foot of sustaining surface per pound.

Mr. *Linfield* was to stand between the two front wheels and actuate two treadles to rotate the screw, which was 7 ft. in diameter; but when the time arrived for testing the machine upon an ordinary macadamized road, it was stated that this could not be done on account of the impossibility of blocking the road during the trial. This was in a measure fortunate, for it led Mr. *Linfield* then to arrange with a railway to mount the machine on a flat car and to tow it behind a locomotive. When a speed of 40 miles per hour was attained the machine rose entirely free from the car, but was not allowed to swerve very far, as there was a side wind blowing, and it swung very close to the telegraph poles as it was. The tow line was some 15 ft. long, and the pull thereon was 24 lbs., which for a 240-lb. machine (without the aviator) indicates an angle of incidence of 1 in 10, or 6°. At this angle, and at a speed of 40 miles per hour, at which the air pressure would be 8 lbs. to the square foot, the total lift for a single plane ought to be $438 \times 8 \times 0.206 = 722$ lbs., so that, if the 240 lbs. of machine was just sustained, it indicates that the very narrow spacing (2 in.) between the superposed aeroplanes greatly interfered with their efficiency.

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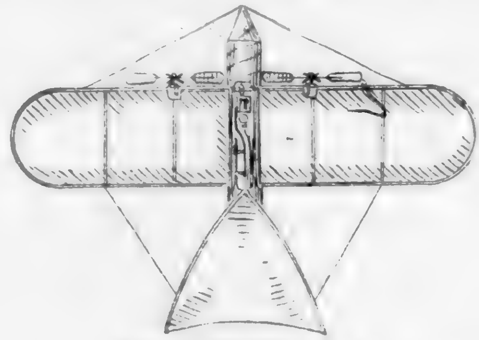

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Such practical experiments being necessarily very costly, I must, to my great regret, forego their undertaking, and I shall be satisfied if my own labors shall induce others to take up such an enterprise.

The effective work done by this aeroplane having been accurately measured, it affords a good opportunity of testing the method of estimating resistances which has been proposed by the writer in estimating the work done by a pigeon.

The weight of M. *Tatin's* apparatus was 3.85 lbs. Its aeroplane surface was 7.53 sq. ft., the angle of incidence was 8°, and the speed was 18 miles per hour, at which the air pressure would be 1.62 lbs. per sq. ft. Hence we have, by the table of "lift and drift":

$$\text{Lift, } 8^\circ = 7.53 \times 1.62 \times 0.27 = 3.29 \text{ lbs.},$$

which indicates that a small part of the weight was sustained by the tail.

The hull resistances are stated by M. *Tatin* to have been almost equal to that of the plane. These hull resistances would consist of that of the tube, of 0.12 sq. ft. midsection, which, having conical ends and parallel sides, will have a coefficient of about one-third of that of its midsection. The resistance of the wheels and running gear will be slightly greater, but must be guessed at, as the wheels would continue to revolve through inertia and thus increase the resistance.

The front edge of the aeroplane, which was of split reed and about one-eighth of an inch thick, was 6.23 ft. long; but as the back edge of the aeroplane and the side borders of the tail would also produce some air resistance, we may call the edge resistance as equal to 6 ft. in length, by a thickness of 0.01 ft., without any coefficient for roundness. We then have the following estimate of resistances:

RESISTANCE OF TATIN AEROPLANE.

Drift 8°	$= 7.53 \times 1.62 \times 0.0381$	= 0.4648 lbs.
Tube	$= 0.12 \times 1.62 \div 3$	= 0.0648 "
Wheels and gear	= estimated	= 0.1000 "
Edges of wings	$= 6 \times 0.01 \times 1.62$	= 0.0972 "
	Total resistance	= 0.7268 "

and as the speed was 18 miles per hour, or 26.40 ft. per second, we have for the effective power required:

$$\text{Power} = 0.7268 \times 26.4 = 19.19 \text{ foot-pounds per second},$$

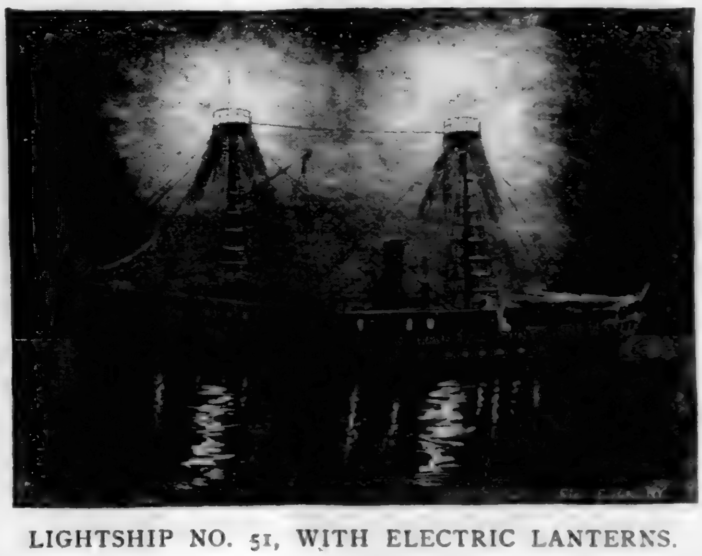
which agrees very closely with the 18.08 to 21.70 foot-pounds per second said to have been effectively developed, and is at the rate of 5 foot-pounds per pound of apparatus, or of 110 lbs. of weight per horse power.

This last is the important point. Now that Mr. *Maxim* has produced a steam-engine which, with its boilers, pumps, generators, condensers, and the weight of water in the complete circulation, weighs less than 10 lbs. to the horse power, aviation seems to be practically possible, if only the stability can be secured, and an adequate method of alighting be devised.

(TO BE CONTINUED.)

THE FIRST LIGHTSHIP WITH ELECTRIC LIGHTS.

IN the RAILROAD AND ENGINEERING JOURNAL for August, 1891, pages 361–64, there was given an illustrated description of Lightship No. 51, designed for the United States Lighthouse Board, the first vessel of her class to be supplied with electric lights. The ship has since been built by F. W. Wheeler & Company, at Bay City, Mich., and will soon take her place off Cornfield Point in Long Island Sound. To complete the account of the vessel we give below an account of the lighting plant, for which we are indebted to the courtesy of the *Electrical Engineer*.



LIGHTSHIP NO. 51, WITH ELECTRIC LANTERNS.

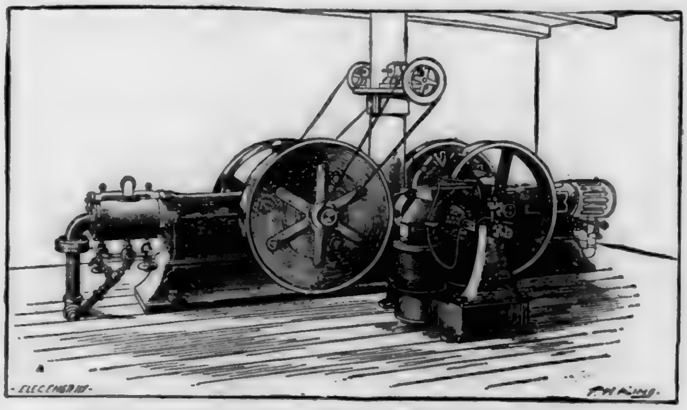
Lightship No. 51 has been fitted with a complete electric plant under the direction and at the suggestion of Commander Coffin, and in accordance with the specifications of Major D. P. Heap, U. S. Engineers, Engineer of the Third Lighthouse District.

Commander Coffin and Major Heap have long been firm in the belief that the incandescent electric light was perfectly adaptable to lightships, certain authorities to the contrary notwithstanding, though the white rays of the arc light are said to be more readily absorbed by fog than those of the oil lanterns in general use, the latter having a yellowish tinge that shows in a fog by contrast.

The incandescent light has, therefore, been employed on No. 51, and the utmost care has been taken to foresee

and provide for all possible accidents to any part of the plant. The entire equipment is in duplicate. The dynamo-room, consisting of a deck-house at the foot of the after mast, contains two Thomson-Houston dynamos wound for 110 volts and having a capacity of 100 lights each. These are driven by two Ideal engines of 8 H.P. each, running at 400 revolutions per minute. The dynamos are fitted with Evans friction cones, and the arrangement is such that each engine can run either generator or both if desired, the change being made very rapidly by means of double-acting ratchets and sliding bed-plates. The actual floor-space occupied by the dynamos and engines does not exceed 9 × 8 ft. Each dynamo is amply capable of lighting the entire vessel by itself, but two are used for the sake of safety. If desired, either generator can furnish current to the masthead lights and the other one to the lamps below decks, and, in fact, the whole system is entirely interchangeable. Duplicate armatures and rheostats are kept ready for emergencies in addition to such accessories as brushes, switches, fuse blocks, etc.

The mast-head lights consist of eight 100-candle-power lamps, four on each mast in multiple. Each lamp is placed in a separate lantern with the triple loop of its filament in the focus of the lens, and the four lanterns are symmetrically placed about the mast-head. Lead-covered Habirshaw cables of seven strands imbedded in the masts



DYNAMO PLANT OF LIGHTSHIP NO. 51.

carry the current to these lights. If, in spite of all the precautions that have been taken, the electric plant, or a part of it, should become disabled, the lamps may be quickly removed from the lanterns, the sockets instantly moved out of the way, and oil lamps substituted while repairs are being made. The lanterns, it should be added, are swung on trunnions to keep the beam of light horizontal. In order to distinguish one from another, light vessels, as well as lighthouses, are provided with revolving lenses, making flashes of a certain duration; thus a ten-second flash with a five-second interval may show the pilot who has lost his bearings that he is not far from the right course, while a 20-second flash and a 15-second interval show him that he is near a dangerous reef. The combinations are infinite in number, and each has its especial significance. In this instance, however, instead of the heavy revolving lens operated by a separate engine and requiring careful attention, a very simple interrupter is used, regulating the length of the flash to a nicety, and entirely automatic in its action. This little device consists of a ratchet-shaped cam revolved by means of worm gear at a speed of one complete turn a minute, and divided into the proper number of steps to produce the particular number of flashes required. The gearing is run by a light helical wire belt from the engine shaft. The cam is made of hard wood with every alternate step covered with copper, and upon its face bear two brushes side by side, but insulated from one another, and included in the mast-head circuit. As the cam revolves, therefore, the circuit is alternately closed and opened at sharp intervals. The whole apparatus is only about 10 in. in height and stands on a little bracket above the dynamos. The flashing device also throws in a resistance equal to the resistance of the mast-head lights. When the latter are extinguished, this prevents the other lights in the ship from flickering.

The wiring of the entire vessel is most carefully and thoroughly done. About twenty lights are used for the necessary illumination between decks. In all cases, the wire is capable of carrying twice the current required without heating, and no effort has been spared to make this installation perfect in every respect. The success of the experiment is a subject for sincere congratulation to all who go down to the sea in ships, and to the electrical engineer, who sees in this experiment another glimpse of the vast possibilities of his profession.

THE UNITED STATES NAVY.

THE new cruiser *Olympia* was successfully launched at the Union Iron Works, San Francisco, November 5, and the *Cincinnati* at the New York Navy Yard, November 10. Both of these ships have been described and illustrated in recent numbers of the JOURNAL.

THE NAVAL RESERVE.

Information has reached the Navy Department that preliminary steps toward the organization of a naval militia have been taken recently in the States of Pennsylvania and Vermont. There are already eight States with properly equipped and creditable naval reserve forces organized in conformity with the national law and receiving aid from the Federal Government. They are Massachusetts, Rhode Island, New York, Maryland, North Carolina, South Carolina, Texas and California. The growth of this branch of the national defense has been extremely gratifying to the Navy Department, and in view of the increased demands upon the National Government for assistance, Secretary Tracy will this year ask Congress to increase from $25,000 to $50,000 the amount appropriated for the equipment of the State naval reserves.

RECENT ARMOR TESTS.

At the recent tests of 14-in. Bethlehem steel plates at the Indian Head proving ground, shots were fired by the 10-in. gun, as provided by the contract, and all the heavy projectiles rebounded, being unable to perforate the plate. The projectiles were all driven back, but while the Holtzer shells suffered from the impact, the Carpenter shells, made in this country, came out in good shape and carried off the laurels from their foreign competitors. This test of 14-in. armor, like the preceding one, shows better results than could have been hoped for a few years ago. Great interest will attach to the approaching trial of the 17-in. turret armor of the battle ships. Against this a 12-in. gun will be used, three shots being fired, with a striking velocity of 1,332 ft. per second.

THE ENGINES OF THE "BROOKLYN."

The Bureau of Steam Engineering has completed the designs for the machinery of the new armored cruiser *Brooklyn*, the sister ship of the *New York*. Although somewhat similar to the machinery of the *New York*, the designs for the *Brooklyn* are in many respects an improvement over the former vessel.

The designs call for four sets of propelling engines, placed in four water-tight compartments, separated by bulkheads. There will be two sets of engines on each shaft. The crank shafts of the two sets of engines for each propeller are so arranged that by means of an easily operated coupling the forward set may be quickly and easily connected with or disconnected from the after one at will. For ordinary cruising the after set attached to each shaft will be used. The engines will be of the vertical, inverted, direct-acting, triple-expansion type, each with a high-pressure cylinder 32 in.; an intermediate-pressure cylinder 47 in., and a low-pressure cylinder 72 in. in diameter, the stroke of all pistons being 42 in.

It is estimated that the collective indicated horse-power of propelling, air-pump and circulating-pump engines should be about 16,000 when the main engines are making about 129 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The crank-shafts will be made in three sections. All shafting will be hollow. There will be one condenser for each propelling engine. Each main con-

denser will have a cooling surface of about 5,681 sq. ft., measured on the outside of the tubes, the water passing through the tubes. For each set of propelling engines there will be two independent double-acting horizontal air pumps, each worked by a single horizontal steam cylinder.

The main circulating pumps will be of the centrifugal type, one for each condenser, worked independently. Each after engine-room will have an auxiliary condenser of sufficient capacity for one-half the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating pump.

There will be five double-ended main and two single-ended boilers (to be used as main or auxiliary boilers) of the horizontal return fire tube type, all to be made of steel. All the boilers will be 16 ft. 3 in. outside diameter. Four of the double-ended boilers will be about 18 ft. long, and one will be 19 ft. 11½ in. long. The two single-ended boilers will be 9 ft. 4½ in. in length, all constructed for a working pressure of 160 lbs. to the square inch. The boilers will be placed in three water-tight compartments, each compartment containing two athwartship fire-rooms. Two double-ended boilers will be placed in the forward and two in the after compartment. In the middle compartment the larger double-ended boiler will be placed on the port side and two single-ended boilers will be placed back to back on the starboard side. Each of the double-ended boilers will have eight corrugated furnace flues, 3 ft. 4 in. internal diameter.

The total heating surface for all the boilers will be about 33,353 sq. ft., measured on the outer surface of the tubes, and the grate surface 1,016 sq. ft. There will be three smoke pipes, each 100 ft. high above grate of lower furnace. The forced draft system will consist of two blowers for each fire-room, the blowers discharging into an air-tight fire-room.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées.*)

(*Continued from page* 515.)

IV.—SOME NOTABLE DAMS.

BELOW are given, as examples and in explanation of the general remarks before made, condensed descriptions of some of the more remarkable dams which have been built in India.

1. *The Myapore Dam.*—This dam, which is shown in fig. 1,* on the accompanying sheet, is on a branch of the Ganges, at the head of the Upper Ganges Canal. It is 516 ft. in length. At the center there are 15 openings, each 10 ft. in width, separated by piers 3 ft. 6 in. thick, raised 7 ft. 10 in. above the face, which corresponds with the level of ordinary low water. The piers have grooves for sliding gates, but the openings can also be closed by gates turning around a horizontal axis placed below. After the dam was built the number of openings was increased to facilitate the regulation of the water. On both sides of this section with openings the dam is formed by a crest or overfall of masonry, which rises by steps from the center of the river to the banks, where it reaches the height of 10 ft. above the central overflow. In low water the crest of these wing-dams, the width of which varies from 7 ft. to 10 ft., is joined to the central piers by a foot-bridge of planks.

The face has a total width of 34¾ ft.; it is composed of solid masonry 5 ft. thick between the piers and 3 ft. thick below the piers. At the ends, above and below, are wings 6 ft. high above the face. The bed of the river is formed of coarse gravel and stones. This work is one of the earliest of the modern dams, dating back nearly 40 years.

Among other dams built on river-beds of a similar kind and in the same part of the country are the Ravi Dam, at the head of the Bari-Doab Canal, and the dam across the Jumna at the head of the Eastern and Western Jumna Canals. These two dams are of almost the same type; they are fixed dams, the first 5 ft. and the second 6 ft. in height, with openings near the end. On the Jumna the face of these openings, to increase the force of the flow, is 3 ft. above the opening into the canal.

2. *The Narora Dam.*—This dam, which is shown in figs. 2 and 3, is comparatively a recent work, having been built in 1875–80. It includes a fixed section 3,700 ft. long, and a section 426 ft. long, with movable gates. The dam is at the head of the Lower Ganges Canal.

The section with gates is at one end near the head of the canal. It is composed of 42 arches having a span of 7 ft., carried on piers 40 in. thick, 20 ft. 9 in. high and 30 ft. long.

The face is 3 ft. below low-water mark. The openings are closed by iron gates sliding in grooves made in the piers, and worked by windlasses placed on a masonry bridge 39 ft. above the floor or face. Fig. 3 is a section through one of the openings. The foundation consists of a mass of masonry resting on brick wells sunk in the river bed.

The chief part of the work is the fixed dam, which is of brick, topped with cut stone. It is 10 ft. high, 7 ft. wide on top and 8 ft. at the base; the lower face is vertical and is protected by riprap, as shown in fig. 2. The dam rests on a foundation or bed of cut stone masonry. This extends for 40 ft. above the dam and rests on a row of brick wells from 20 to 25 ft. deep. To present a more complete barrier to leakage through the sandy bed of the river the intervals between the wells are filled by rows of piles, the spaces between the rows being filled with concrete, forming a complete screen. Transverse rows of wells assist in supporting the dam. Above the foundation riprap is extended for 100 ft.; this is cut by two parallel masonry walls about 5 × 5 ft., the object of which is to hold the stones in place against the force of the current.

3. *The Okla Dam.*—This dam, a section of which is shown in fig. 4, is on the Jumna, eight miles from Delhi, at the head of the Agra Canal; it was finished in 1874.

This is a fixed dam, with openings close to the right bank of the river, and is 2,440 ft. long. It has no foundation, resting directly on the river bed, which here consists of a fine sand which packs down very hard. Before building the dam the bed was leveled off. It is a comparatively simple structure, consisting of two parallel walls of masonry 9 ft. high and 4 ft. wide placed 26 ft. apart. The space between these walls is filled in with stone, and an immense mass of loose stone is piled around them, extending some 180 ft. above the dam and 40 ft. below it. A wall of masonry 4 × 5 ft. extends across the river about 40 ft. above the upper wall of the dam, its object being to prevent too great a movement of the stones.

At this point the level of high water is on an average 11 ft. above that of low water, and the current attains a speed of 7 to 8 ft. per second. Notwithstanding the rapidity of the current and the fact that at seasons of flood the dam holds back about four-sevenths of the entire cross-section of the river, it has stood remarkably well.

4. *The Dehri Dam.*—This dam was built about 1875 on the Soane, a tributary of the Ganges. It is of the same type as the Okla dam, and is remarkable for its great length, 12,460 ft. The Soane, the valley of which has an area of nearly 2,350 square miles, has at the point where the dam is built a fall of about 2.64 ft. to the mile, with a maximum velocity of current in flood seasons of 11¼ ft. per second; the difference of level between high and low water being 16 ft. The river-bed is of coarse sand and pebbles.

The dam is composed of three parallel walls of unequal heights 33 ft. apart. The foundations consist of masonry wells of quadrangular form sunk 10 ft. below the level of the river-bed. The crest of the dam is 9 ft. above low water. The spaces between these walls are filled in with loose stone and riprap is carried for some 45 ft. above the upper wall and 30 ft. below the highest one. A floor or bed of masonry extends about 18 ft. back of the highest wall. The surface of the dam has a slope of 1 to 2 above the crest and of 1 in 10 below it.

There are three openings in the dam, one near each bank and one in the center. A canal starts from the river

* The figures in the text have been reduced to feet and inches, but in the engravings they are given in meters.

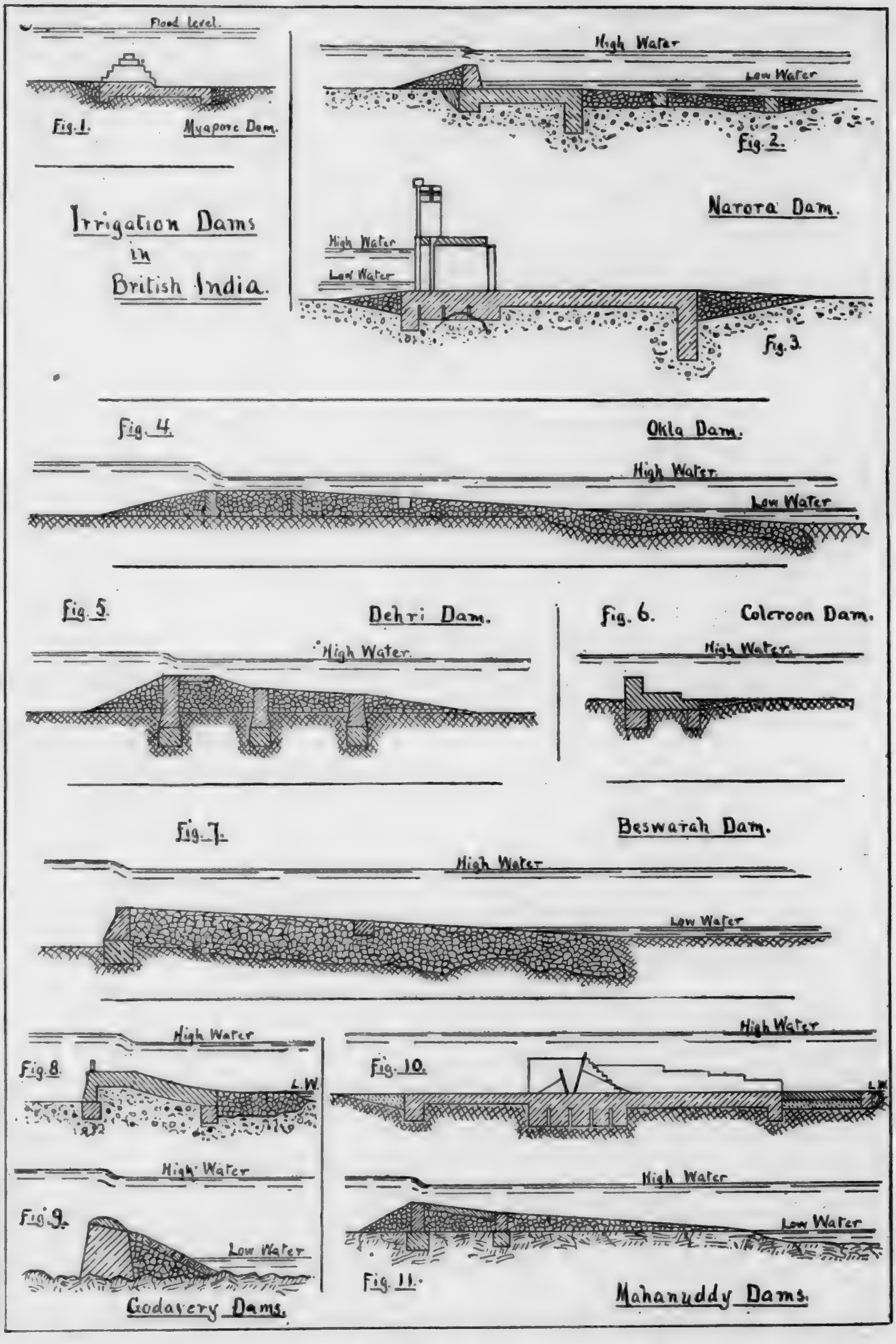
on each side. These openings are each about 500 ft. in length and are divided into spans of 20 ft. They are closed by gates similar to those of a Chanoine dam. Above these gates are fenders pivoted on horizontal axes, and so arranged that they are kept up by the force of the current. These form a screen behind which the gates are worked.

These flood openings are floored with masonry resting on rows of brick wells sunk in the river-bed. The spaces between the wells were dredged out and then filled in with concrete.

The Roopur Dam, on the Sutlej, at the head of the Sirhind Canal in the Punjab, is a work of a very similar type.

5. *The Coleroon Dam.*—This is an old dam, dating from 1834, and is on a branch of the Cauvery River, near the head of its delta. Its object is to throw back into the main stream of the Cauvery the water which would otherwise pass into the Coleroon branch. It is of much use in the system of works for the irrigation of the delta.

The dam consists of a masonry wall, of the section shown in fig. 6, rising 7 ft. above the river-bed at the highest point, and sunk about 3 ft. below it. The foundation consists of a double row of brick wells only 5½ ft. in depth. The masonry extends back from the main wall 22 ft. in the form of an apron, and beyond this there are 9 ft. of riprap. The river-bed is of fine sand.



While this dam cuts off the current of the Coleroon entirely in low water, it has little effect in floods rising 10 ft. above low-water level.

6. *The Beswarah Dam.*—This dam is on the Kistna, about 60 miles from its mouth and near the head of the delta, at a point where the river is shut in two ranges of hills about 4,000 ft. apart. The depth of the river varies from 5 to 6 ft. in the dry season and to 30 and sometimes 40 ft. during the monsoons.

The dam consists of a mass of loose stone rising to a height of 23 ft. above the lowest point of the bed and 14 ft. above low-water level. The dam is in all 3,750 ft. long and 200 ft. in width. At the upper end the mass of riprap is held in place by a brick wall of the section shown in fig. 7. This wall is 12 ft. high and has a crown of cut stone 6 ft. wide. It rests on a foundation consisting of a double row of brick wells sunk 7 or 8 ft. into the alluvium which forms the bed of the river. A light wall extending across 90 ft. below the main wall serves to hold the stone in place against the action of the current. The stones on the surface of the dam are very large, many of them weighing 2 tons each.

At each end of the dam there is an opening, the object of which is to scour out the bed at the heads of the two canals which start, one on each bank. Each opening con-

sists of 15 arches of 6 ft. span, and these are closed by sliding gates. The entire masonry is covered at high water.

7. *The Godavery Dams.*—The first of these is a comparatively simple work, consisting of a masonry wall of the section shown in fig. 9, founded directly on the rocky bed of the river. This wall is of rough stone and is protected below by riprap. It is 5,250 ft. in length and has an average height of 15 ft. At its greatest height—25 ft.—this wall is 23 ft. thick at the base and 17 ft. at the top; the thickness decreases to 13 and 10 ft. where the wall is 15 ft. high. The extreme rise of the river in floods is about 40 ft.

The most important work on the Godavery is at the head of the delta, about 30 miles from the sea. Here the Godavery, which has a valley covering about 100,000 square miles, and which rises about 30 ft. in floods, has a total width of 3½ miles, divided by islands into four channels. The dam is extended in a straight line across the entire width of the river by works of various kinds—earth dikes and riprap dams pierced at intervals by openings with movable gates, and finally by a masonry dam. The total length of the masonry is about 2.4 miles. The river-bed is of sand extending to a great depth.

The fixed masonry dam consists of a revetment of masonry covering a bank of sand carefully rammed down. The crest is 12 ft. above the river-bed. This revetment consists of a vertical wall 12 ft. high, then a horizontal face 18 ft. wide, and finally a slope, slightly concaved and 25 ft. in width. The foot of this slope is protected by riprap. At each end of the masonry is a row of brick wells forming a foundation. This work is shown in section in fig. 8.

On the crest of the dam are placed movable gates or flash-boards, which can increase the height of the dam 2½ ft. when it is desired to hold back the water.

At the season of the highest flood this dam holds back about two-sevenths of the cross-section of the river.

8. *The Mahanuddy Dams.*—At the head of the Mahanuddy delta there are three distinct works. The first is the Naraji Dam built across the Katjori arm of the river, and intended to divert its waters to the two principal branches. This is a vertical wall rising 10 ft. above low-water level and extending across the river in an oblique direction. It is founded on an old bed of riprap which at some unknown period had been thrown into the sandy bed of the river. It is protected below from the current by stone carefully selected and piled up. This dam is 3,600 ft. long. The river rises here at times to a height of 30 ft., and its delivery in flood is estimated at 700,000 cub. ft. per second. The location of this dam in a line oblique to the current is recognized as a source of weakness, as it causes dangerous eddies which are liable to scour the foundations. The only opening is near the right bank, and permits a sufficient amount of water to pass to supply the city of Cuttack.

The second dam is 1,970 ft. long, crossing the Beropa arm of the river. It is similar to the third—described below—and has two series of openings closed by Chanoine gates. It is 9 ft. in height. At each end is the head of a canal. The river-bed is of sand, except for a short distance, where it is rock.

The third dam, known as the Cuttack Dam, is 6,350 ft. long, and rises to a height of 12 ft. above low water. It is of a type similar to the Dehri Dam, consisting of parallel walls 30 ft. apart, the space between filled in with stone. Above the upper and below the lower wall are masses of riprap. The walls are founded on rows of cylindrical brick wells. For part of the length of the dam there are three parallel walls; the rest of the distance there are two only, as shown by the section in fig. 11. At the dam the river-bed is of sand, and the average rise in floods is 22 ft. above low water.

Near each end is a row of openings, and at the center is an opening of 500 ft. divided into 10 spans of 50 ft. each. These are closed by Chanoine gates provided with fenders; a section through one of the openings is shown in fig. 10.

The three Orissa canals start from this dam, and from them the entire delta is irrigated. The three dams of the Mahanuddy have been the most expensive works of the kind in India, and their maintenance expenses yearly are about 1 per cent. of the first cost.

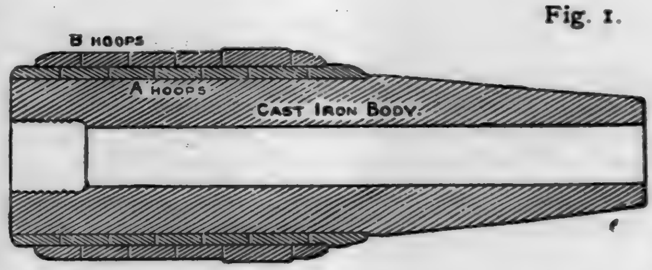
(TO BE CONTINUED.)

THE NEW BREECH-LOADING MORTARS.

SOME reference has been made from time to time to the new rifled mortars which hold an important part in the plans for the new system of coast defense. Contracts were made for 73 of these guns, to be 12 in. caliber, cast-iron body, steel-hooped and weighing 14½ tons each. At the present time 37 of these have been delivered, and work on the others is in progress. The contract was let to the Builders' Iron Foundry, Providence, R. I., and to a handsome pamphlet issued by that company we are indebted for the facts given in this article.

The mortars in appearance very closely resemble the steel breech-loading rifles made by the United States Navy

Fig. 1.



Department, with the exception of their length, which in the rifles is about 30 times the diameter of the bore, and in the mortars only 10 times.

The cast-iron bodies have a 12-in. bore, are 129 in. long and 31½ in. diameter, and the diameter over the steel hoops, which are shrunk on the bodies in two rows, as shown in the accompanying sketch, is 42½ in.

The specifications in the contract call for the castings for the bodies to be made from charcoal pig, and to be cast vertically, breech downward; to be cooled by the circulation of water through the core, according to the Rodman process. Test specimens cut from both muzzle and breech ends of the mortar to have an elastic limit of about 17,000 lbs. and a tensile strength between 30,000 and 37,000 lbs. per square inch, or nearly double the strength of ordinary cast iron; one-fifth of the entire casting to be cut off for a shrink or sinking-head.

The metal is also tested for specific gravity and hardness. The latter is a comparative test, and is made by forcing a standard steel pyramid into the metal and noting the depth to which it sinks under a given pressure.

The metal is melted in what is known as an air furnace, and the casting and cooling operations are conducted with the greatest care.

When ready the casting is placed in a gun lathe, which is of heavy build with a long boring-bar attachment instead of a tail-stock. The gun is held and driven by a large chuck on the face-plate, and the other end of the casting runs in a semicircular bearing or steady rest. The boring-bar has no rotary movement, but is fed toward the face-plate and carries a reamer-like cutter-head which enlarges the hole by several cuts to 11.8 in. Meanwhile, ordinary turning tools are turning down the chase or forward taper and parting off the test disks and shrink head. The parting tools are run in nearly to the bore, the gun body is removed from the lathe and the disks broken from the casting by wedge and sledge. The hole is next enlarged to within 0.1 in. of the final diameter.

The steel hoops preparatory to shrinking are faced at the ends and bored to 31.5 in. diameter, 0.003 being the allowed variation from exact size.

The outside of the body is now accurately turned to a varying diameter slightly larger than the inside of the hoops to be shrunk thereon. This difference is called the "shrinkage," and it varies along the entire length to be hooped, the purpose being to place each of the hoops under nearly equal tension. As might be supposed, the diameter of the bore is slightly decreased when the hoops are shrunk on.

The hoops are heated in a gas furnace, are slipped over the body and up to their proper place, a pressure of 100

tons being used to make a tight joint between each hoop and the one next to it. They are gradually cooled by a stream of water, which is brought to bear first on the forward end of the hoop and then moved slowly backward. There are two tiers of hoops, as shown in the section.

then swung round out of the way. The shot is raised by a crane and shoved in, and the powder follows in a bag. The tray is then swung back to its first position and the breech-block is run in by turning the translating roller-crank handle, and locked by the revolving gear handle.

RAILROAD STATION AT CAPE TOWN, SOUTH AFRICA.

The next step is the fine boring, which must be within 12.000 and 12.003 in. diameter, and straight enough to allow a test cylinder 11.997 in. in diameter and 42 in. long to slip easily through the bore.

The next operation is the rifling, which requires the greatest care and exactness. In this rifling 68 grooves are cut, 0.379 in. wide and 0.07 in. deep, and these grooves

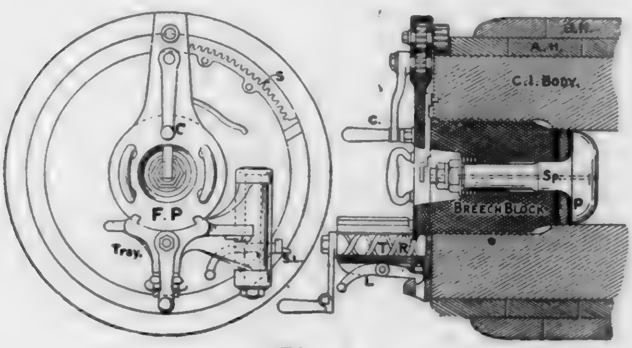


Fig. 2.

have an "increased pitch" varying from one turn in 25 caliber to one in 40: the object being to avoid a too sudden initial rotation of the shot when fired. The next operation is the threading for the breech-block which is done with a special machine.

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LINDNER'S STARTING-VALVE.

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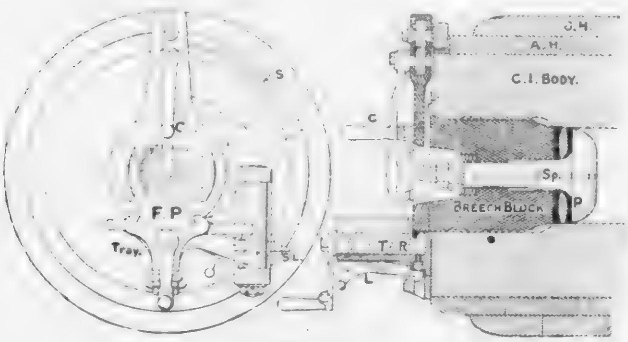
tons being used to make a tight joint between each hoop and the one next to it. They are gradually cooled by a stream of water, which is brought to bear first on the forward end of the hoop and then moved slowly backward. There are two tiers of hoops, as shown in the section.

then swung round out of the way. The shot is raised by a crane and shoved in, and the powder follows in a bag. The tray is then swung back to its first position and the breech-block is run in by turning the translating roller-crank handle, and locked by the revolving gear handle.

RAILROAD STATION AT CAPE TOWN, SOUTH AFRICA.

The next step is the fine boring, which must be within 12.000 and 12.003 in. diameter, and straight enough to allow a test cylinder 11.997 in. in diameter and 42 in. long to slip easily through the bore.

The next operation is the rifling, which requires the greatest care and exactness. In this rifling 68 grooves are cut, 0.379 in. wide and 0.07 in. deep, and these grooves



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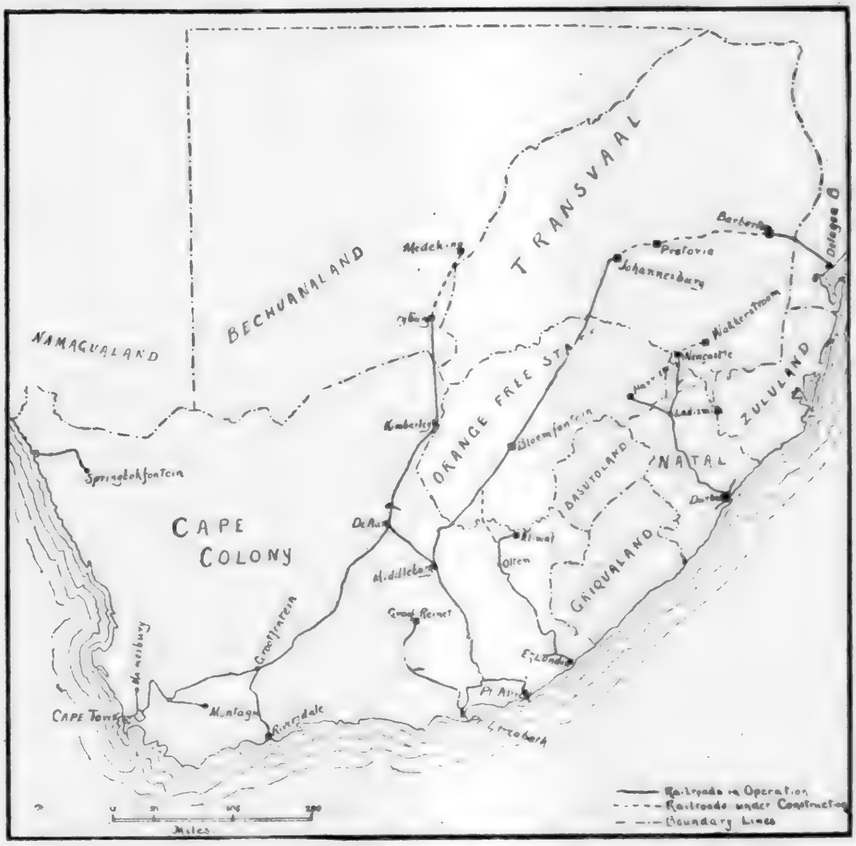

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LOCOMOTIVE RETURNS FOR THE MONTH OF AUGUST, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	55	38,949	77,748	37,708	154,405	2,807	....	....	[illegible]	84.39	51.54	69.44	....	...	4.30	4.30	0.31	0.50	[illegible]	[illegible]	17.61	....	...	....
Alabama & Vicksburg	....	17	18,370	14,041	11,252	43,663	2,569	....	....	45.87	83.33	41.67	58.31	....	....	3.20	4.90	0.27	0.70	6.20	1.80	19.07	....	....	....
Atchison, Topeka & Santa Fé	834	739	....	....	378,487	2,327,080	3,149	....	....	...	....	....	77.61	....	....	4.89	6.24	0.29	0.11	6.61	1.38	19.53	....	...	1.56
Canadian Pacific	598	....	508,050	731,516	482,863	1,722,429	2,880	...	....	....	....	...	58.77	....	...	3.54	9.98	0.40	....	5.23	1.30	20.45	....	1.75	3.22
Chic., Burlington & Quincy	517	....	....	....	....	1,902,765	3,680	5.70	18.84	....	....	....	75.90	....	....	4.80	4.92	0.20	0.19	6.57	....	16.68	....	...	1.30
Chic., Milwaukee & St. Paul	806	....	....	....	....	2,707,443	3,359	....	....	....	....	....	64.60	....	....	3.54	6.61	0.28	....	6.86	....	17.29	....	....	2.00
Chic., Rock Island & Pacific	552	....	684,681	1,012,386	408,659	2,105,726	3,815	....	....	52.62	70.55	38.22	57.92	....	....	2.61	5.44	0.27	....	5.99	0.38	14.69	....	....	2.00
Chicago & Northwestern	871	....	734,489	1,414,029	861,966	3,010,484	3,456	....	...	....	....	....	75.30	....	....	3.38	7.01	0.36	....	6.34	0.80	17.89	....	....	1.84
Cincinnati Southern	....	97	84,826	164,027	82,353	331,206	3,415	....	....	60.81	112.36	36.90	81.63	....	....	4.40	4.70	0.28	1.30	6.50	1.80	18.98	....	....	....
Cumberland & Penn*	23	22	5,479	33,345	....	38,824	1,765	....	....	....	....	....	81.30	....	....	6.12	4.50	0.40	....	....	1.70	12.72	....	....	....
Delaware, Lackawanna & W. Main L.	208	192	....	....	....	674,377	3,512	....	....	....	....	....	73.56	....	....	3.17	5.66	0.43	...	5.63	....	14.89	....	....	....
Morris & Essex Division	157	....	176,683	240,721	13,333	430,737	2,745	....	....	....	....	....	59.26	....	....	4.05	9.18	0.42	....	6.08	...	19.73	....	....	3.08
Hannibal & St. Joseph	[illegible]	70	76,677	172,180	37,838	286,695	4,096	5.55	17.30	....	....	....	76.83	11.03	5.36	9.16	5.26	0.19	0.13	6.18	....	20.92	....	....	....
Kan. City, F. S. & Mem.	143	....	104,529	226,514	109,216	440,259	3,078	....	....	....	....	....	58.17	....	...	3.78	4.63	0.32	0.36	7.30	....	16.39	....	....	1.54
Kan. City, Mem. & Birm.	41	38	37,107	52,971	18,060	108,138	2,846	....	....	....	....	....	57.92	....	....	3.86	3.41	0.25	0.37	7.21	....	13.10	....	....	1.13
Kan. City, St. Jo. & Council Bluffs	43	42	62,843	49,661	51,006	163,510	3,803	5.07	21.53	...	....	....	58.52	11.18	4.49	4.16	5.05	0.12	0.08	5.72	....	15.13	....	....	1.80
Lake Shore & Mich. Southern	587	....	448,981	696,696	613,518	1,759,195	2,996	....	....	55.02	79.45	31.82	57.11	....	....	3.10	4.47	0.12	0.04	6.99	0.21	14.93	....	....	1.56
Louisville & Nashville	....	†341	450,957	798,967	416,815	1,666,739	3,665	5.12	16.12	60.24	104.37	56.80	76.70	11.84	6.26	4.19	6.28	0.27	1.41	6.11	0.60	18.86	3.17	1.45	1.63
Manhattan Elevated	....	273	767,011	....	52,135	819,146	3,001	....	....	....	....	....	40.57	....	....	2.90	8.10	0.30	....	8.70	....	20.00	....	....	3.99
Mexican Central‡	146	116	....	....	....	395,418	3,409	....	.. .	...	....	....	67.80	....	....	4.74	13.62	0.46	0.19	5.47	0.80	25.28	....	....	4.82
Mil., L. S. & Western	112	....	84,437	184,633	117,344	386,414	3,450	....	....	....	....	....	67.14	....	....	2.81	9.21	0.25	....	6.10	0.86	19.23	....	....	2.75
Minn., St. P. & Sault Ste. Marie	....	....	68,991	137,652	60,762	267,405	....	4.88	18.52	...	....	...	61.86	....	....	3.33	10.28	0.19	....	6.39	....	20.19	..	1.63	3.31
Missouri Pacific	339	308	....	....	....	1,254,630	4,076	4.78	17.17	....	....	....	79.33	13.25	5.76	4.49	5.77	0.39	1.10	6.41	1.34	19.50	3.82	1.32	1.43
N. O. & Northeastern	....	33	30,676	44,228	24,465	99,369	3,011	....	....	64.52	100.00	34.01	73.26	....	....	5.60	6.20	0.32	0.50	6.30	1.70	20.62	....	...	....
N. Y., Lake Erie & Western	....	618	478,335	917,867	292,409	1,688,611	2,732	4.90	21.70	83.70	120.40	60.60	....	17.00	5.60	5.18	6.62	0.41	1.85	7.22	1.16	22.44	....	1.70	....
N. Y., Pennsylvania & Ohio	....	257	144,287	439,309	144,116	727,712	2,532	6.20	18.00	76.00	114.70	65.90	....	12.20	6.40	4.55	5.62	0.31	2.38	6.75	1.00	20.61	....	1.70	....
Norfolk & Western, Gen. Eastern Div.*	....	142	102,758	262,280	55,213	421,251	2,964	4.80	20.10	....	...	....	95.68	....	....	8.20	2.90	0.80	....	....	....	11.90	....	....	....
General Western Division*	....	115	63,969	224,391	27,485	315,845	2,739	4.70	15.70	....	....	....	125.00	....	....	12.50	3.60	0.70	....	....	....	16.80	...	....	....
Ohio & Mississippi	113	....	149,146	157,727	92,961	399,834	3,538	...	....	....	....	....	65.08	...	....	3.78	2.84	0.21	0.89	5.40	1.27	14.49	....	....	0.86
Old Colony	232	....	386,829	131,695	127,369	645,893	2,784	....	....	....	....	....	56.35	....	....	2.74	10.57	0.63	....	6.59	0.77	21.30	....	....	3.73
Philadelphia & Reading	....	....	497,818	623,710	548,723	1,770,251	....	....	....	....	....	....	73.58	....	....	4.59	4.10	0.32	....	5.72	0.40	15.13	....	....	....
South. Pacific, Pacific System	713	...	....	....	....	1,923,729	2,698	....	....	....	....	....	70.32	....	..	5.02	18.35	0.36	1.57	7.38	1.59	34.27	....	...	5.27
Union Pacific	994	....	741,880	1,432,658	477,930	2,652,468	2,668	5.59	17.35	....	....	....	88.53	13.70	6.85	6.96	8.00	0.39	0.73	8.01	1.08	25.17	4.22	1.76	1.80
Vicksburg, S. & P.	....	14	10,858	10,488	9,576	30,922	2,209	....	....	46.84	79.36	28.49	53.05	...	....	6.60	5.90	0.22	1.20	6.70	3.00	23.62	....	....	....
Wabash	401	351	420,558	736,975	289,022	1,446,555	4,124	5.18	18.38	65.70	94.07	49.97	77.01	12.67	5.11	3.07	4.35	0.27	....	6.20	0.80	14.69	2.59	0.91	1.13
Wisconsin Central	150	130	133,013	237,049	77,339	447,401	3,442	....	....	....	....	....	73.42	....	....	3.32	9.34	0.29	....	7.16	....	20.11	....	....	2.42

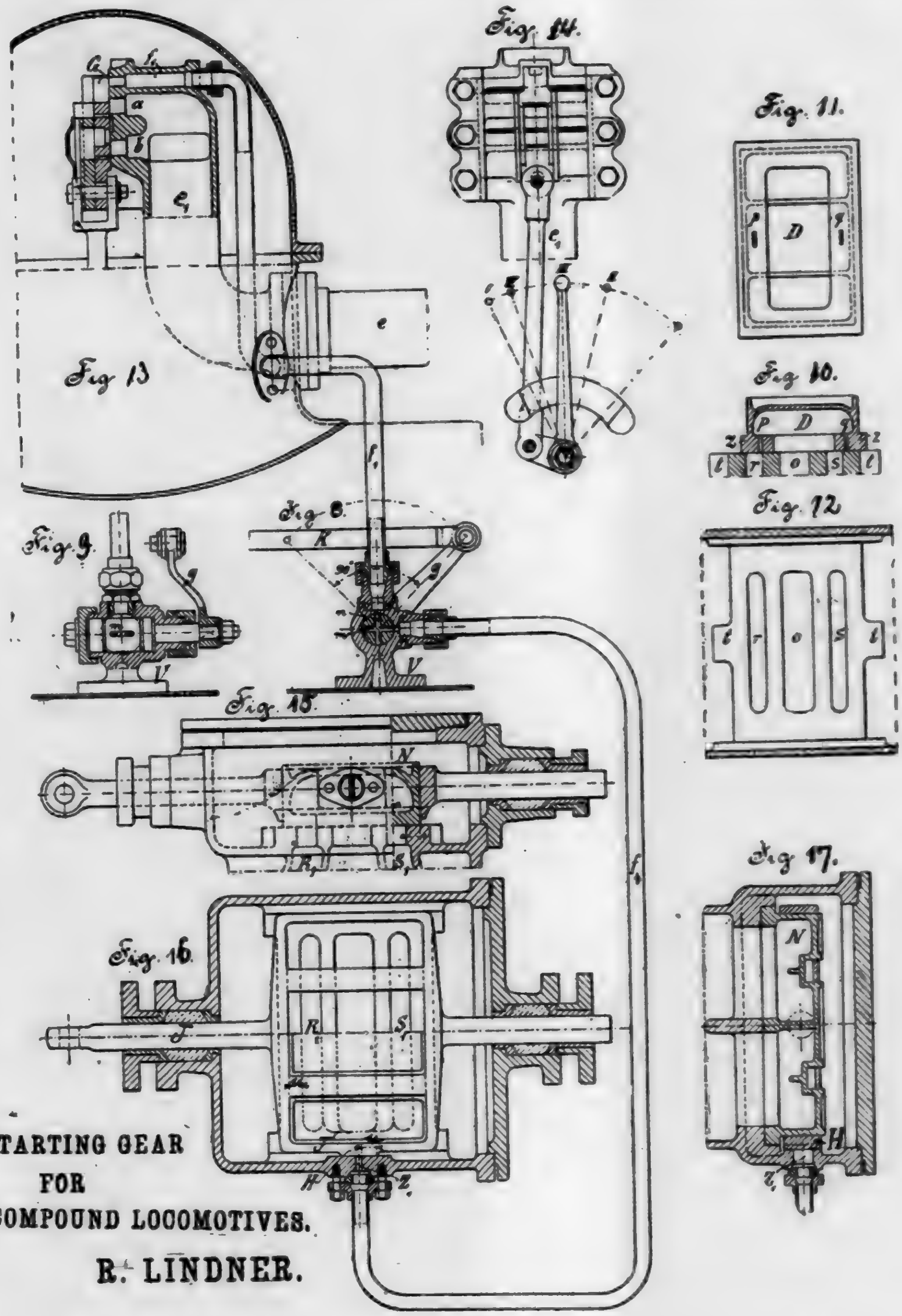
NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Wages of engineers and firemen not included in cost.

† Number of engines in revenue service only; average mileage is also based on revenue service.

‡ The Mexican Central Railroad reports 19.2 units of work per $1 of expense; 163.3 units of work per ton of coal; 12.25 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

"In order to regulate the entrance of steam from the pipe f^4 into the steam-chest of the low-pressure cylinder *B*, attach a slide *H* to the valve-buckle *N*, as shown in fig. 16. This slide *H* is integral with or firmly secured to the low-pressure slide-valve *N*, the valve-rod *J*, or valve-buckle *J'*. The latter, as shown, slides on the bottom of the slide-valve case and the slide *H* at or about at middle height of the same. By making the lap *u* of the slide *H* equal to the outside lap *u* of the valve *N*, one of the ports *R'* or *S'* is opened or closed at the same time the port *Z'* opens or closes. When the slide *H* is in its middle positions, which is always the case when not starting by means of the low-pressure cylinder, the port *Z'* is covered, and thus steam is admitted to the low-pressure slide-valve chest only when it can proceed to the low-pressure cylinder by one of the ports *R'* or *S'*. The entrance of steam from the low-pressure valve-chest into the receiver *C* is thus prevented, except when said steam has also admission to the low-pressure cylinder. The amount of steam passing the cock or valve *V* will be regulated by the slide-valve *e'* (illustrated in detail by figs. 13 and 14), and also attached to the engine. The slide of this valve has a lug *G* cast on, which covers or uncovers the port leading into the pipe *f'*. The motion of the slide is regulated by the handle illustrated by fig. 14, which can be moved from one position to the other (indicated by the numbers 1 and 5). At 1 the ports are all closed, and no steam can enter the same. While moving from 2 to 5, the main ports *a* and *b*, leading into the high-pressure pipe *e*, are opened. At the beginning and ending of this opening the port leading into the pipe *f'* will be closed. The opening thereof only takes place while the handle is moved between 3 and 4, and while passing from 4 to 5 the port *f'* will be full open. The steam admitted to the high-pressure cylinder *A* by the steam-pipe *e* exhausts into the low-pressure cylinder *B* through the pipe *C C*, which at the same time serves as a receiver, and the steam of the low-pressure cylinder *B* exhausts into the air or into a condenser. The high-pressure slide-valve *D* is provided with ports *p q* on the exhaust side (see figs. 10 and 11) in order to relieve the high-pressure piston from unequal strain, as the steam has admission to both sides of the same. These ports *p* and *q* place the exhaust-port *o* in communication with the two steam-ports *r* and *s* as soon as the valve *D* shuts off. The bar *z* is either equal to or greater than the breadth of the ports *r* and *s*, so that steam cannot pass from the valve-chest into the exhaust-port *o*, but allows of steam passing from the exhaust-port into the back and front side of the cylinder."



STARTING GEAR FOR COMPOUND LOCOMOTIVES.

R. LINDNER.

Recent Patents.

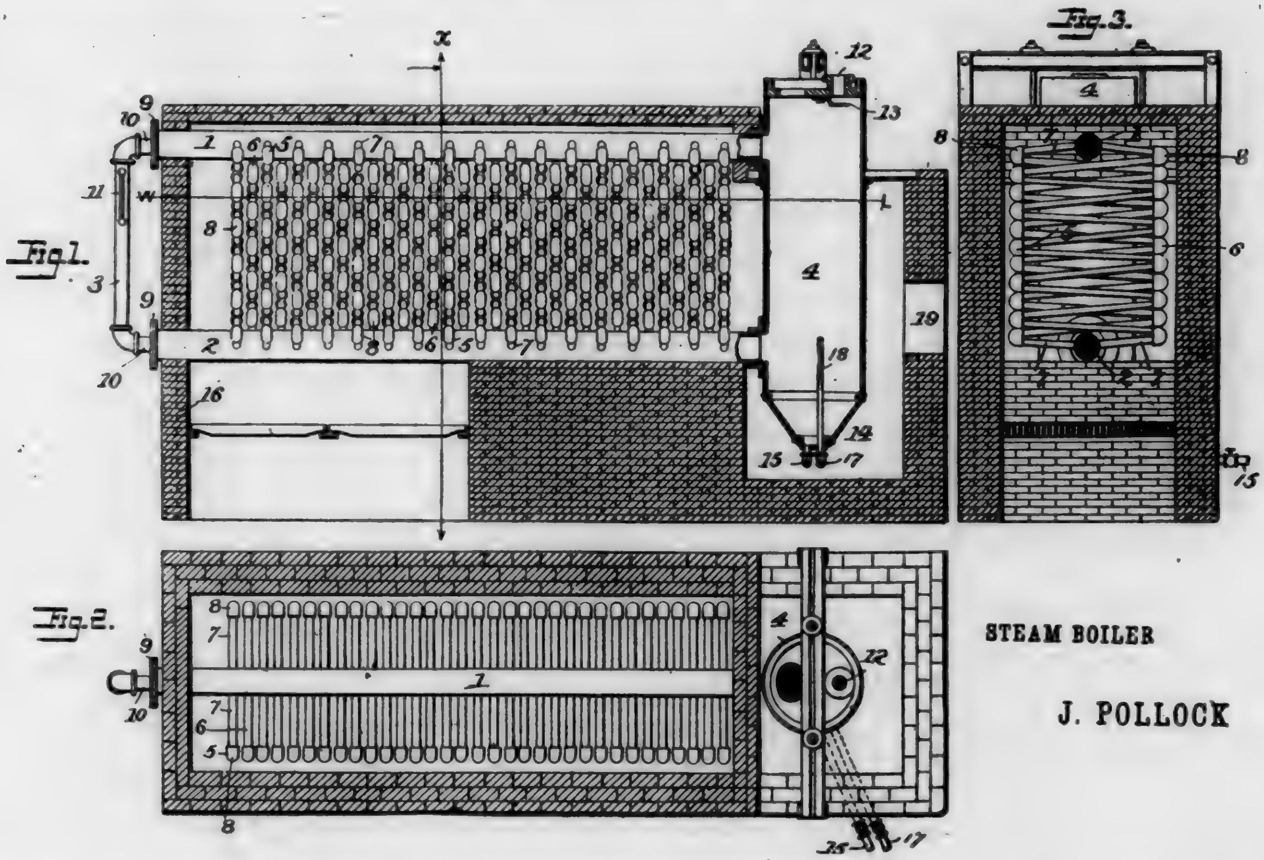
POLLOCK'S WATER-TUBE BOILER.

In figs. 1, 2, and 3 is shown a new form of water-tube boiler, for which patent No. 482,459 was recently issued to James Pollock, of Wilkes-Barre, Pa. Fig. 1 is a side elevation, partly in section; fig. 2 is a plan, and fig. 3 is a cross-section on the line *X X* in fig. 1. The patentee describes his invention as follows:

"The principal parts of the boiler are a horizontal steam-drum 1 at the top and a horizontal water-drum 2 at the bottom, a vertical pipe 3, connecting the forward ends of the drums, a vertical chamber 4, communicating with the rear ends of the drums, and two series of zigzag pipes 5 6, arranged between the drums within the furnace. The zigzag sections or pipes 5 of one series are fitted to one side of the steam-drum and to one side of the water-drum, and the sections 6 of the other series are fitted to the opposite sides of the drums and cross and recross the sections 5 a number of times, thus forming a maze of pipes through which the hot gases from the furnace are compelled to travel. The upper and lower members 7 of the zigzag sections are reversely threaded at their ends and screw into the drums and the return-bends 8. Any section of the zigzag pipes may be quickly removed by simply unscrewing the portions 7 at its top and bottom, and, if necessary, a new coil of pipe may be substituted, the coils being all exactly alike and interchangeable.

"The front ends of the drums are closed by plates 9, bolted to flanges on the drums, and these plates are tapped to receive short pipes 10, to which the vertical pipe 3 is attached. The pipe 3 is tapped above and below the water-line *W L*, to receive the ends of a glass gauge 11 for indicating the level of the water in the boiler.

"As above stated, a great objection to water-tube boilers is that a large amount of moisture in the form of water is carried off with the steam. This is partly due to the fact that a portion of the steam is formed considerably below the water-line, and in passing through the narrow tubes to the steam-drum it necessarily agitates the water violently and tends to carry off a



STEAM BOILER

J. POLLOCK

considerable amount of it. Furthermore, it has been considered necessary heretofore to keep the tubes full of water to prevent them from burning out. I have found that portions of the tubes may be safely and profitably located above the water-line and that the water carried up by the steam will be vaporized in the heated tubes and at the same time keep the temperature of the tubes down to prevent injury to them. Thus the steam is rendered dry and partially superheated.

"As an extra precaution against wet steam I take the steam from a port 12 in the upper part of the enlarged casing or chamber 4, where the water is less agitated than in the tubes, and I locate a baffle-plate 13 opposite said port. The casing or chamber 4 is preferably cylindrical, except at the bottom, where it terminates in a conical section 14 and a blow-off pipe 15. The steam-drum 1 is riveted to the upper part of the casing and the drum 2 is riveted to the lower portion. The casing 4 acts as a setting-chamber, as the water-currents in it are very sluggish and the bulk of the dirt and impurities in the water settle into the conical bottom and may be readily drawn off through the blow-off pipe 15. Should any dirt accumulate in the drums, it can be readily removed by taking off the plates 9 and inserting a suitable flue-cleaner. For this purpose the drums are extended through the front wall 16 of the furnace.

"The feed-water may be introduced into the boiler at any point; but I prefer to connect the feed-pipe 17 to the casing 4 near its lower end and to provide its inner end with a perforated or spray pipe 18. In this way the coolest water in the boiler is always nearest the flue 19, where the gases pass out of the furnace, and in this way the escaping gases are reduced to the lowest possible temperature and the greatest economy obtained."

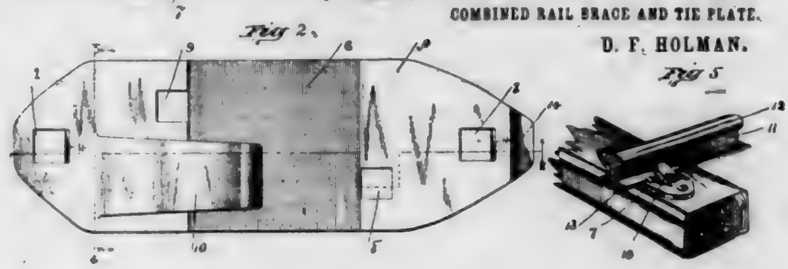
HOLMAN'S RAIL-BRACE AND TIE-PLATE.

The accompanying illustration shows a combined rail-brace and tie-plate, for which patent No. 485,384 was recently issued to Danial F. Holman, of Chicago.

In the drawings fig. 1 is a vertical longitudinal section of a combined tie-plate and rail-brace and a cross-section of a rail secured thereto. Fig. 2 is a top plan view of the tie-plate and rail-brace. Fig. 3 is an end elevation of the same. Fig. 4 is a cross-section on the line 4 4 of fig. 2, and fig. 5 is a perspective view of a portion of a tie and a rail-section secured thereto by a tie-plate and rail-brace constructed in accordance with this invention.

These drawings show the device so plainly that but little description is needed. The under face of the plate is concaved, as shown at 5 in figs. 1 and 4, the result being that the tie-plate will adapt itself to the inequalities in the surface of the tie, and will rest firmly thereon. The edges of the tie-plate will also be embedded to a certain extent in the tie, which provides an additional resistance to the spreading and adds to the strength of the track.

Some of the advantages claimed are stated by the inventor



COMBINED RAIL BRACE AND TIE PLATE.

D. F. HOLMAN.

as follows: "This invention can also be applied to an old track as well as new tracks, and to facilitate such the end of the tie-plate removed from the arm 10 is sharpened or beveled, as at 14, so that the said tie-plate can be easily driven beneath a rail that is already laid. It will be further obvious that to remove a rail secured by my invention it is only necessary to remove one spike in each plate—namely, the inner spike 7, or the one passing through hole 8.

"The combined tie-plate and rail-brace herein described can be made to fit any size rail, and in a track constructed with this invention the rails are strengthened, the ties will last longer, the spikes will act with greater efficiency, and the solidity and stability of the track is materially increased."

Foreign Naval Notes.

SOME interesting trials of torpedoes were recently made in the River Plate. In these the attacking boats were judged to be uniformly successful, and the conclusion reached by the witnesses was that a night attack by a torpedo squadron would be an extremely dangerous affair for a large ship, the chances being altogether on the side of her active enemies.

ARMOR TESTS IN ENGLAND.

Some interesting armor-plate tests were carried out November 1 on board the target vessel *Nettle*, at Portsmouth, England. Messrs. Vickers & Company, Sheffield, were some time ago commissioned by the Government to manufacture a nickel-steel plate and to treat it in accordance with the Harvey process, by which great hardness is communicated to the surface, together with a proportionate amount of toughness, so that the increased brittleness which commonly attends the hardening of steel is obviated. This plate has been completed, and was the one tested.

The trial, which was conducted by Captain Hugo Pearson, of the *Excellent*, was witnessed by Mr. W. H. White, C.B., Director of Naval Construction, Admiral Colomb, General Geary, R.A., Captains Jenkins and McKechnie, of the Ordnance Committee, Colonel W. W. Barlow, late of Woolwich Arsenal, and other officials. The Harvey Steel Company, of New York, was represented by Mr. Edwin M. Fox and Mr. Joseph H. Dickinson, and the manufacturers by Messrs. Albert and Thomas Vickers.

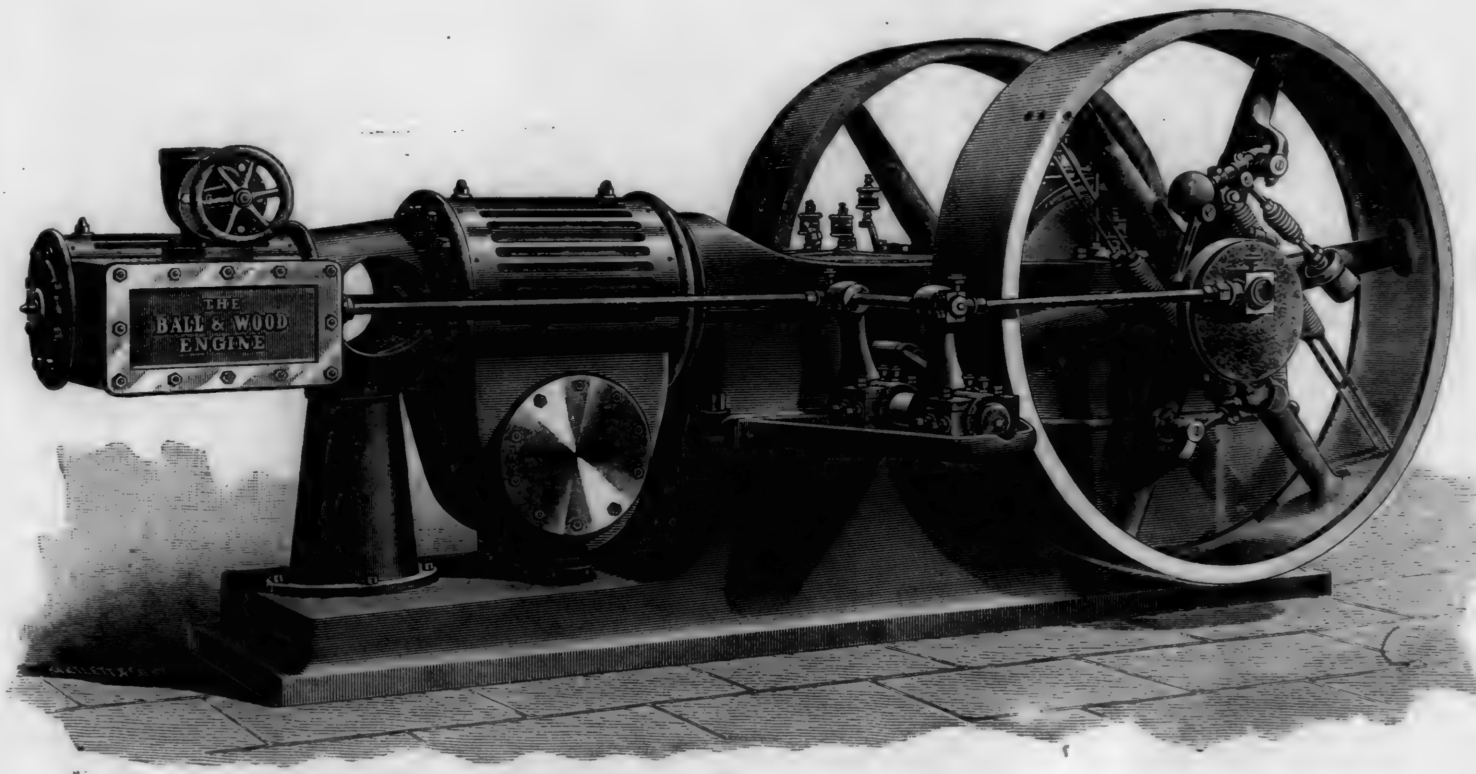
The plate measured 6 ft. $\times$ 8 ft., with a thickness of 10½ in. The test, for purposes of comparison, was of the ordinary character consistent with Admiralty conditions. This consisted of discharging five rounds at the target from the 6 in. breech-loader. The charge was 48 lbs. of E.X.E. powder, the weight of projectile 100 lbs., and the muzzle velocity 1,975 ft. per second. The rounds were fired in the following order: (1) Holtzer steel shell at bottom right-hand corner; (2) Holtzer at upper left-hand corner; (3) Palliser shell at upper right-hand corner; (4) Palliser at upper left-hand corner; (5) Holtzer in the center.

The results of the firing were most successful. The Palliser projectiles, although they splashed upon the plate on impact, made indents of about 1¼ in. in depth. The Holtzers, on the other hand, appeared to weld their points into the target before bursting into a thousand highly heated fragments. The feature of the trial, however, was that the plate withstood its punishment so well that not a single crack was produced.

Further trials with thinner plates are to be carried out at Portsmouth, the results of which we look forward to with considerable interest.—*Industry, London.*

A New Tandem Compound Engine.

THE accompanying illustration, which by the courtesy of the builders we publish in advance of the appearance of their new catalogue, shows one type of an improved tandem compound engine built by the Ball & Wood Company. This engine has some novel and excellent features, a distinctive one being a new low-pressure valve recently invented by Mr. Ball. It has the advantage of quickly relieving the cylinder of water in case of flooding, and is, in its ease of action and small percentage of clearance, a decided advance on the valves heretofore used on this type of engine. Another good point is the manner in which the high-pressure cylinder is supported and allowance made for expansion and contraction.



NEW TANDEM COMPOUND ENGINE, BY THE BALL & WOOD COMPANY.

The governor used on this engine is of the well-known type made by this company and approved by continued use. To show the confidence placed in it we quote a clause of the guarantee under which every engine is sold: "That the engine shall not run one revolution slower when fully loaded than when running empty; and that no reduction of boiler pressure shall reduce the speed of the engine one revolution until the latest point of cut-off is reached, the same result being obtained when driving from either the governor wheel or balance wheel, or both."

The engraving shows very well the general design and arrangement of the engine It is an exceedingly neat machine in its finish and general appointments. It is well known that our best types of engines will compare favorably with those of English or French manufacture, and that in this department, as with locomotives, our builders have no reason to fear comparison or competition from abroad.

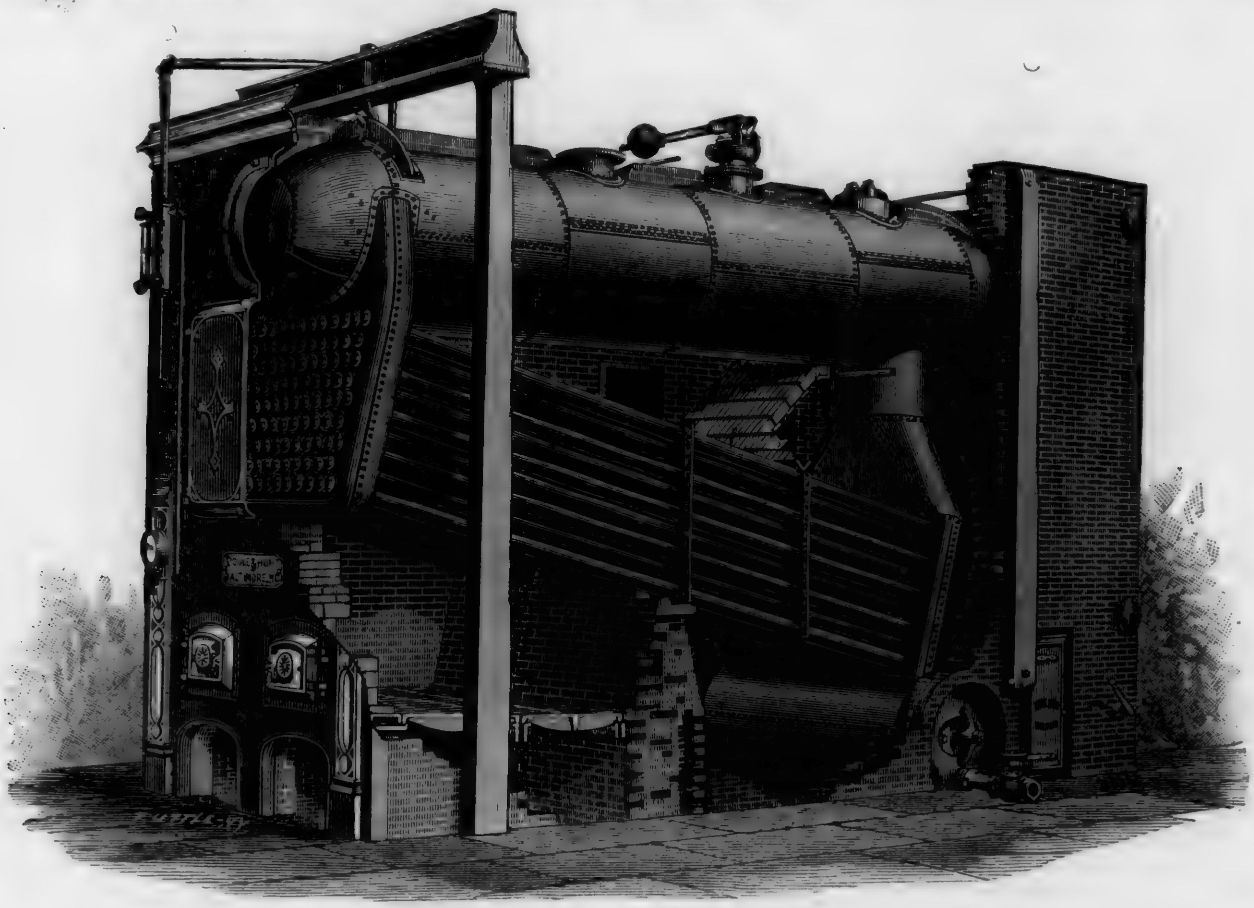
The Ball & Wood Company, whose office is at No. 15 Cortlandt Street, New York, have lately built new shops at Elizabethport, N. J., which are very fully supplied with tools of the most approved patterns, electric cranes and all the facilities for turning out a high class of work.

Manufactures.

The Poole Water-Tube Boiler.

THE illustration given herewith shows an excellent form of sectional or water-tube boiler made by the Robert Poole & Son Company, of Baltimore. The advantages claimed for this class of boilers are so well known that it is hardly necessary to restate them here.

The boiler shown is composed of lap-welded wrought-iron tubes, placed in an inclined position, and connected by vertical passages at each end, with a horizontal steam and water drum. The tubes are staggered, or so placed that one row comes over the spaces of the previous row. The vertical passages, or end connections, are made of two plates of the best flange iron, or steel, placed far enough apart to give full area for the circulation between the inclined tubes and horizontal drum. The plates are flanged at sides and bottom, and very strongly stay-bolted together. The tubes are expanded into the inner plate, and suitable hand holes in the outer plate admit the tubes and allow for cleaning. The connection to the drum is made in the strongest manner. The fire is made under the higher end of the tubes, and the products of combustion pass up between the tubes into a combustion chamber under the steam and water-drum ; from thence they pass down across the tubes, then once more up through the spaces between the tubes, and off to the chimney.



THE POOLE WATER-TUBE BOILER.

The water, being inside the tubes, as it is heated tends to rise toward the higher end, and as it is converted into steam—the mingled column of steam and water being of less specific gravity than the solid water at the back end of the boiler—rises through the front end connection into the drum above the tubes, where the steam separates from the water, and the latter flows back to the rear and down again through the tubes in a continuous circulation. As the end connections are large (the full area of the tubes being maintained), this circulation is very rapid, and produces, the makers claim, three very important advantages :

" 1. It sweeps away each particle of steam as fast as formed, and supplies its place with a particle of water, thereby absorbing the heat of the fire to the best advantage ; and, thoroughly separating from the water in the large disengaging surface in the steam and water drum, prevents what is known as priming or foaming, the steam passing away from the boiler dry even when the boiler is forced to its utmost capacity.

" 2. It causes a thorough commingling of the water throughout the boiler, and a consequent equable temperature, thus preventing those very serious strains from unequal expansion which occur in all boilers of ordinary construction, and which are a frequent cause of explosions.

" 3. The rapid circulation prevents, to a great degree, the formation of deposits or incrustations upon the heating surfaces, sweeping them away and depositing them in the mud drum, at the rear and lowest point of the boiler, whence they are blown out."

A hand-hole at the end of each tube permits access thereto for cleaning should they become scaled by the use of very bad water, and man-holes in the steam and mud drums admit access to them for the same purpose. Should it be necessary, for any cause, a tube may be readily removed and another substituted. The front end of the boiler is suspended from a girder, supported by columns, entirely independent of the brickwork, and all the mountings, including gauges, safety valve, etc., are of the best and most approved patterns.

It will be seen that the boiler has all the advantages of its class. It is especially serviceable where high pressures have to be carried on account of its safety from explosion, ease of repairs and the quickness with which the pressure can be brought up.

A number of boilers of this type are in use, and they have given good results in all cases.

Subdivision of Power.

THE subdivision of power in large manufacturing establishments (by which is meant the substitution of several small engines in place of one large engine, and the distribution of power in the form of steam rather than by shafts and belts) has been a matter of active discussion of late. Originally looked upon as an experiment which might show against the fuel account, it was some time in gaining the confidence of manufacturers, as well as of engineers. The most persistent advocates of subdivided power, as engineers, have probably been Messrs. Westinghouse, Church, Kerr & Company, and many important plants have been designed by them on this basis. The results are beginning to speak for themselves, and are of interest.

When the great Spreckels sugar refinery was built some four years ago, and it was announced that Chief Engineer Watson and his associates had finally settled upon the radical departure of subdivided power throughout, many conservative engineers doubted the wisdom of an experiment upon so large a scale, and involving a position from which there was no line of retreat nearer than a complete reconstruction of the plant. It may be imagined that the decision was not arrived at except after the most deliberate investigation, but having been made, the problem was attacked boldly. Not only was the subdivision of power so completely carried out as to involve over 60 engines distributed on every floor of the enormous building, and practically doing away with shafting and belts altogether, but high-speed engines were selected, and most of them set without foundations. Non compound engines were employed, from the fact that the various processes utilized all the exhaust steam which could be made.

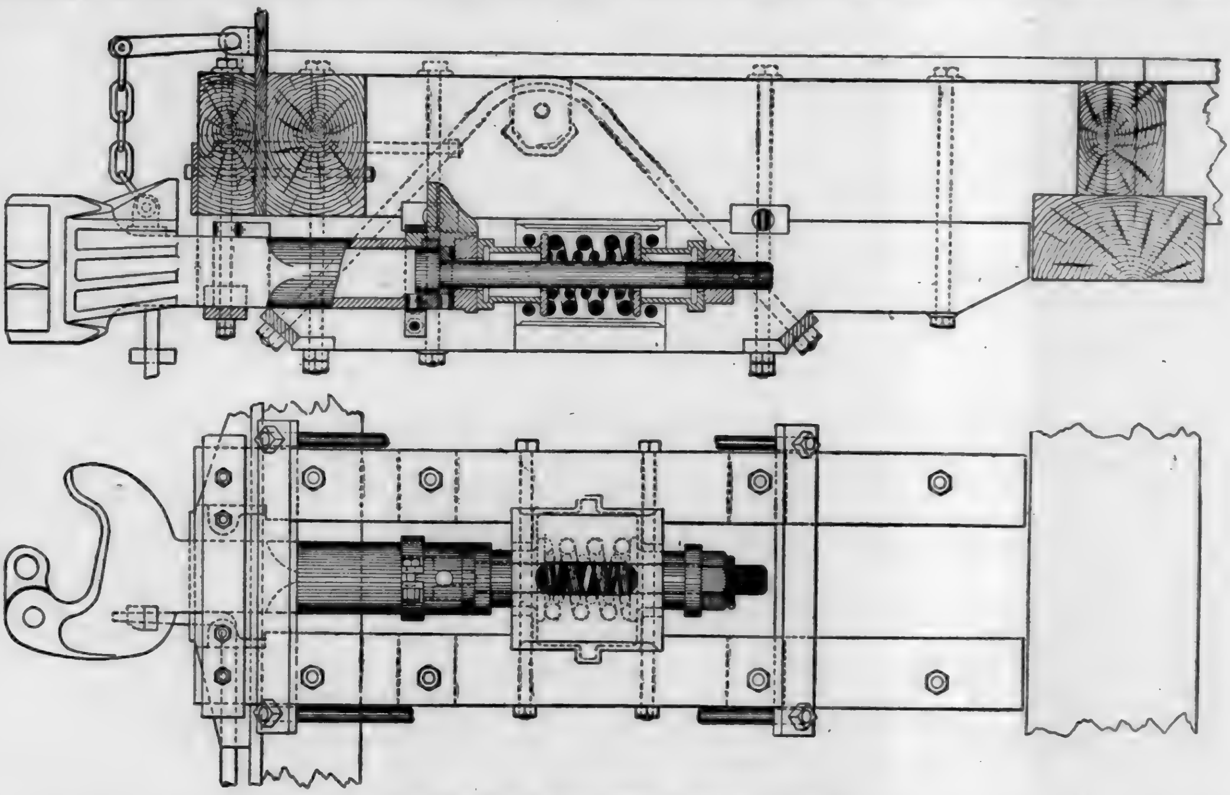
This refinery has since passed into the ownership of the American Sugar Refining Company, and further enlargements are now in progress. The experience of three years of operation, literally night and day, was brought to bear upon the question of future extension of power, and the decision may be taken as significant of the general result obtained. An order has just been placed for five more Westinghouse standard engines, four of 100 H.P. and one of 75 H.P., making 68 engines now operating in this refinery.

An interesting feature developed in this establishment has been in the matter of repairs and stoppages. The Master Mechanic keeps on hand a set of duplicate parts for each size of engine, and covering such parts of the engine as are most subjected to accident or wear. When a part is worn out, or an accident occurs, he gives the spare part to the engineer in charge of that particular department and it is at once put in place; the old part being returned to the shop and overhauled at leisure. In this manner there is no measurable delay in the refining processes, which is the paramount consideration, and the maintenance account is reduced to practically nothing.

A similar subdivided plant, involving 42 engines, was installed at the print works of the Dunnell Manufacturing Company, Pawtucket, R. I., and its Chief Engineer reports that the total repair bill for the first year of continuous operation was less than $3.

The Butler Drawbar Attachment.

THE drawings given herewith are from the catalogue of the Butler Drawbar Attachment Company, and show one form in which these attachments are used. The special feature of this construction is the truss-rods which are used for binding the draft timbers more rigidly to the center sills. Two flat bars extend across the two draft sills and beneath them, and passing through each end of each bar and over a cast-iron pocket provided in the center sills for their reception are the two truss-rods, one being on the outside of each draft sill. Directly underneath the draft sill and lying against the iron bars referred to are additional bars gained into and firmly bolted against the draft sills. The corners of the bars coming in contact prevent them from moving from their proper positions. A regular standard attachment of the Butler Drawbar Attachment Company is used. This attachment consists of the two castings which form the spring pocket and the springs and thimbles contained therein.



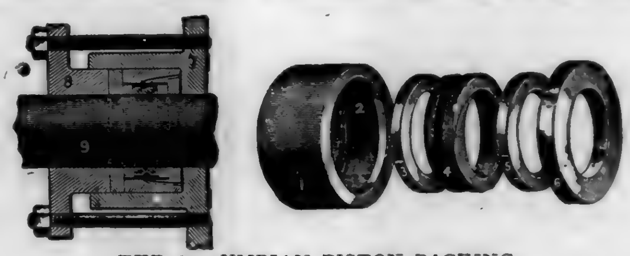
THE BUTLER DRAWBAR ATTACHMENT.

This drawing shows the ordinary draft-rod and nut on the drawbar. In another form a yoke extends around the attachment and spring and is riveted to the drawbar, making a very strong and simple connection.

These are only two of the ways in which the Butler attachments can be applied. They can be used to advantage with almost any of the ordinary forms of drawbar.

The Columbian Metallic Packing.

THIS packing, which is shown in the accompanying illustration, is self-adjusting, and has some features for which many advantages are claimed. A reference to the cuts will show that



THE COLUMBIAN PISTON PACKING.

it consists of a cut packing ring 4 of soft metal, placed between wear-plates 3 and 5 of hard metal. These are in the case 1, and are closed steam-tight by the sealing-plate 6.

The case and sealing-plate fit loosely into the stuffing-box, and by screwing up the gland the case is forced against the bottom of the stuffing-box, forming a steam-tight joint to prevent escape of steam between stuffing-box and case.

If the bottom of the stuffing-box is too rough to form a per-

fect joint, a washer or ring of any kind of soft metal may be placed against it, and a tight joint can be made without difficulty.

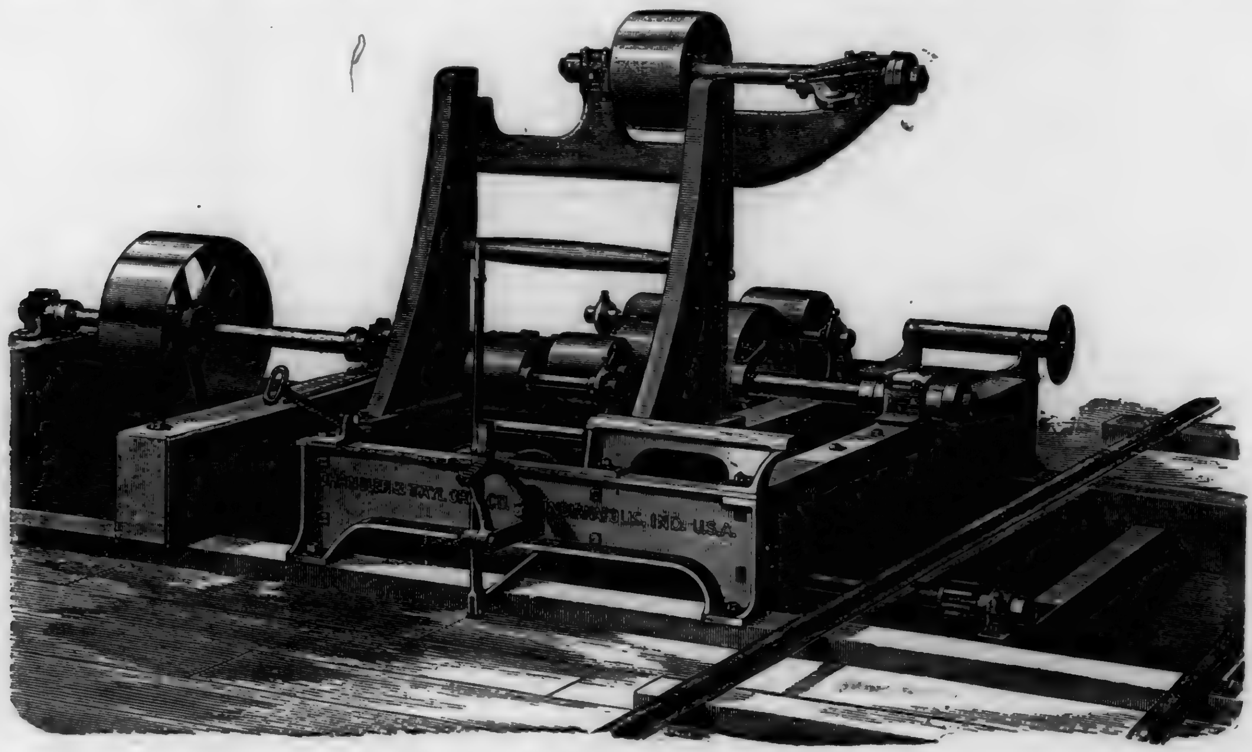
The bottom of the case is dished to form a steam chamber, and port-holes 2 leading from this chamber admit steam into the case ; the steam pressure acting against the back of the cut packing ring 4 closes it on the rod 9.

Where there is no steam in the end of the cylinder forming the stuffing-box, these ports may be closed by small plugs.

Among the advantages claimed for this packing are that it can be used in any ordinary stuffing-box without alteration ; no fibrous packing is required ; it will adjust itself automatically ; it works uniformly and reduces friction ; it is adapted for use with almost any kind of engine ; it is simple and easily fitted ; and it works with great uniformity.

A New Saw-Mill.

The illustration given on this page shows a saw-mill of a new design, built by the Chandler & Taylor Company, in Indianapolis, Ind., a concern which has had much experience with machinery of this kind, and has placed mills in many parts of the country.



NEW SAW-MILL BY THE CHANDLER & TAYLOR COMPANY.

The leading features given to this their latest design are a large mandrel with self-adjusting self-oiling boxes and an extension shaft with clutch coupling and lever and independent boxes which relieve the mandrel of the pull of the main belt, giving increased space for off-bearing and furnishing a means for driving edgers, cut-offs, log hauls, etc., without the intervention of a line shaft.

The Heacock patent belt-feed is provided with all mills of this design, which, aside from independent steam-feed, is the simplest and most powerful feed devised. With this arrangement the feed can instantly be changed by means of a single lever, shown in the cut at the sawyer's position, to give from no feed to $4\frac{1}{2}$ ft. in the medium mill and from nothing to $7\frac{1}{2}$ ft. feed on the heavy mill. The patent right for this valuable feature is owned by this company, and from practical tests made it has been demonstrated that the addition of this feed to mills already in use has increased their daily capacity from 1,000 to 2,000 ft.

A choice is given of carriage propulsion by rack and pinion, or by wire cable ; the latter is usually preferred where long timbers are to be sawed. The carriage is supported by large track-wheels with axles extending from side to side of carriage, and these wheels in turn rest upon a track made of ordinary steel rails. The arrangement for sustaining the top saw mandrel is also to be noted. This mandrel is provided with an adjustable self-oiling device, and with devices whereby the teeth of the upper saws are made to cut out under the bark and carry the sawdust out of instead of into the kerf. These special devices, with the general details, arrangement and parts of the whole outfit, make a complete and substantial mill. Four sizes of these mills are built, all made after the general design shown in the cut and covering a range of capacity from the smallest to the largest.

Car Head-Linings.

No greater advance has been made in any department of passenger car construction during recent years than in the manufacture of head-linings. Many readers can remember the painted head-linings, generally of gaudy and tasteless patterns, which were common a few years ago, and which are still occasionally seen in old cars. From these to the paneled head-linings of to-day there has been a great advance ; but even these left something to be desired.

This has apparently been supplied by a new invention, the special feature of which is the application of raised or embossed decorations of tasteful pattern to the wood panels. While not intended as an imitation of wood-carving, these decorations present very much the same effect. The process is owned and controlled by the manufacturers, and the panels produced are not only handsome but strong and apparently very durable, the decorations or embossing put on by the company's process becoming attached to—or, it might be said, incorporated with—the panel in such a way that when cut or sawed through they seem to be part of the wood itself.

In this way very handsome panels for head-linings are produced at a cost not exceeding that of the linings now in use. Of course the effects can be varied according to taste by the use of panels of various kinds of wood in combination with different decorations.

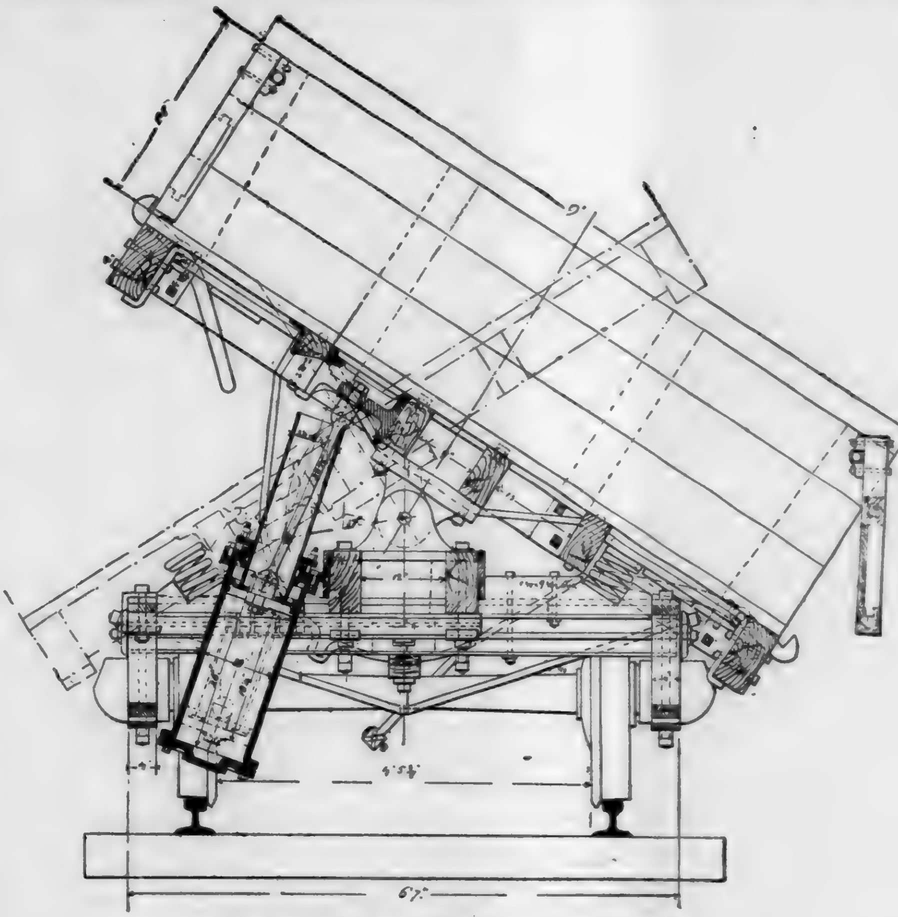
These head-linings are manufactured by the Bowers Manufacturing Company, of Newark, N. J. On a recent visit to the company's shops, in Harrison, a number of panels were seen in process of manufacture, including panels of quartered oak, maple and other woods, and some very beautiful work in white and gold, the latter being intended for some cars under construction for a new electric line. Car-builders who want to turn out handsome cars will find these new decorations well worth inspection.

The Thacher Pneumatic Dump Car.

An interesting exhibition of the capacity of this car for quick work was given recently on the Erie road at Garfield, N. J.

The cars used had been in active service, and their operation was so quick that it was hardly possible to time it.

The machinery of the car is simple, the operation of dumping being performed by a piston working in a cylinder underneath the car, to which compressed air is admitted. If the car is to dump on one side only, it is level when the piston is at the bottom of the cylinder; but if it is made to dump on either side, it is level when the piston is at the center of the cylinder. The air is taken from the reservoir on the locomotive; or an additional reservoir can be carried if it is considered necessary. Two train-pipes lead from the reservoir, and the air can be admitted to either end of the cylinder as required. The accompanying drawing shows a section of the car with the body raised to dump.



THE THACHER PNEUMATIC DUMPING-CAR.

The latching and releasing device by which the car body is held level while running, or released when it is to be dumped, is controlled by a small cylinder which in the later patterns is cast in one with the large cylinder. It has no separate pipe, but the air passes through it to reach the dumping cylinder; an arrangement which makes it certain that unlatching will take place before the power is applied to lift the car body. The latching device is a simple one, and will spring back and hold the car body level as soon as the latter is thrown back into place.

Of course the simplest form is that in which the car dumps on one side only; but there is very little additional complication where it is made to dump on both sides. It can also be readily applied to coal cars dumping in the center. There is no doubt that it saves time and labor, and some experiences already had seem to show that it will stand the rough usage to which dump cars are often exposed.

These cars are made by the Thacher Car & Construction Company, of New York. A number have been in use on a narrow-gauge line in Colorado for some time; and the Canadian Pacific Company has 50 of large size in use, and at present employed in filling a high trestle near Vancouver, where they are said to work very much to the satisfaction of those in charge.

Lake Ship-building.

The Detroit Dry Dock Company has just closed a contract with Detroit parties for a "straightback" steel steamer 362 ft. long, 42 ft. beam and 24 ft. deep, to be an almost exact duplicate or sister ship to the steamer *Selwyn Eddy*, now nearing completion at Wyandotte. The only difference between the *Eddy* and the new contract is that there will be no gangways. The boilers will be on the main deck instead of in the hold and sheer to bulwarks on the side.

Lake ship-builders now have contracts to build during the coming winter, for delivery at about the opening of navigation, 49 vessels, valued at $6,909,500. These totals, together with the valuable detail regarding the new tonnage which is contained in the accompanying table, were secured through correspondence with every ship-builder on the chain of lakes, and the comparison with fall contracts in previous years is made in accordance with a similar inquiry in the past. The record in both the number of vessels and aggregate value for this year is very much ahead of the two previous years, but it will be found by a glance at the comparative table that in both number and carrying capacity the showing in large freight-carrying steamers is somewhat smaller than in any year for six years past. This is due largely to the fact that three of the most important steel yards are crowded with work on the large passenger vessels. Twenty-eight freight steamers and consorts, of 68,470 gross tons capacity, will, however, be added to the fleet of this class of vessels in the spring.

The following table shows the number and value of contracts on November 1 of this year as compared with contracts on the same date in previous years:

Winter of	Number of Boats.	Capacity gross tons.	Valuation.
1886-87	31	65,750	$4,074,000
1887-88	60	108,525	8,325,000
1888-89	59	100,950	7,124,000
1889-90	56	124,750	7,866,000
1890-91	38	77,950	5,337,000
1891-92	45	76,000	4,896,000
1892-93	49	68,470	6,909,500
Total	338	632,395	$44,531,500

The totals represent simply the winter work of the ship-yards and not their entire work for the several years.—*Cleveland Marine Review.*

Baltimore Notes.

The Baltimore & Ohio Railroad Company has just finished at Benwood, W. Va., one of the most complete round houses in the country. It is about 300 ft. in diameter, and has stalls for 24 engines. The ash-pit is 200 ft. long, which is three times the usual length, and will admit of the cleaning of three engines at a time. An immense coal dump for furnishing the engines with coal has also been built, and several large water tanks have been constructed. The bridge which connects Bellaire, O., and Benwood is being strengthened on the west side, so as to admit of the crossing of the heaviest engines in the service. It is also intended to lay 11 miles of tracks and to build new repair shops in the yard at Benwood.

The laying of track for the new alignment of the Baltimore & Ohio near Cumberland has been begun, and it is expected that the new short line will be ready for service in about a month. As soon as this is completed, the work of grading for the new yard will be begun.

In addition to placing orders for a number of new engines, the Baltimore & Ohio Railroad Company has arranged with the

Baldwin and the Pittsburgh Locomotive Works for repairing a large number of their locomotives.

THERE are 20 extra large box cars being built at the South Baltimore Car Works for the use of the Rothschild's Sons Company, of Cincinnati, over the Baltimore & Ohio. The above firm manufactures bar fixtures, and the cars are 38 ft. long inside.

IT is expected that the Ohio & Mississippi will shortly make an increase in their freight equipment by about 1,000 cars.

THE 100 logging cars building at the South Baltimore Car Works for the West Virginia & Pittsburgh Railroad are equipped with Fox pressed steel trucks and with 30-in. wheels, in order that they may be as low on their trucks as possible.

THE South Baltimore Car Works have added a passenger car shop to their plant for the purpose of carrying on repair work, and have arranged with the Baltimore & Ohio for repairing 200 passenger cars.

General Notes.

THE Harrisburg Foundry & Machine Company, Harrisburg, Pa., is very busy, and has its shops so full of work that it is extending their capacity generally. An extension of the boiler shop is in progress, and a new automatic riveting machine is to be put in.

THE Ranken & Fritsch Foundry and Machine Company's shops, in St. Louis, are running day and night to keep up with orders. Several large orders have lately been received from the gas belt in Indiana, chief among which was that for a large rolling mill outfit and paper mill. They are furnishing five large Corliss engines, which include a cross compound condensing engine, 26 × 44 × 48, a 20 × 42 condensing engine and a 16 × 36 condensing engine.—*Age of Steel.*

THE shops of the Frick Company, in Waynesboro, Pa., are now employing about 700 men, and are full of work. Recent orders for ice machines include one 20-ton machine for the Crisfield Ice Company, Crisfield, Md.; 50-ton machines for the Springfield Ice Company, Springfield, O., the Pottstown Ice & Cold Storage Company, Pottstown, Pa., and the Thomas Conville Brewing Company, New York; one 150-ton plant for the Hauck Brewing Company, Cincinnati; one 300-ton plant for the United Beef Company, New York. In the engine department orders include one 150-H.P. Eclipse Corliss engine for the Eastman Kodak Company, Rochester, N. Y., and one 200-H.P. engine for the United Beef Company, New York.

THE Dickson Manufacturing Company, in Scranton, Pa., is building a large quadruple-expansion engine for the Edison Illuminating Company of New York. The engine is of the vertical inverted type, with the cylinders arranged in pairs tandem, and acting on two cranks placed at an angle of 90°. The dynamo will be built up around the main shaft, taking the place of a fly-wheel. The cylinders are 26 in., 37 in., 52 in. and 72 in. in diameter and 36 in. stroke. With a boiler pressure of 210 lbs. and at 100 revolutions per minute the engine is rated at 2,500 H.P. This is the first large engine of this type built in this country.

THE Cooke Locomotive Works, Paterson, N. J., recently delivered to the Newport News & Mississippi Valley Company eight passenger engines with 18 × 24-in cylinders and 63-in. drivers. They are to run the through trains between Louisville and Memphis.

THE Safety Car Heating and Lighting Company is making preparations for an extensive exhibit at the World's Columbian Exposition to be held in Chicago next year. This will not only show their system of lighting as applied to ordinary coaches, but also to sleeping and drawing-room cars, as well as the gas-lighted buoys, which have been generally adopted by this Government as the means of lighting the various channels and harbors along our coast.

THE firm of Shailer & Schniglau, of Chicago, has secured the contract for building the Canal Street lifting bridge, which will be operated by four powerful chain belts.

THE Pittsburgh Bridge Company, Pittsburgh, Pa., has secured the contract for erecting the Halsted Street lifting bridge in Chicago, which will be operated the same as the Canal Street bridge.

THE Link-Belt Machinery Company, Chicago, is putting in a complete system of rapid freight-handling machinery in the new warehouses of the Flint & Père Marquette Railroad, at Milwaukee. The plant comprises three elevators and six conveyers. The merchandise is delivered directly from the wagons to the link-belt elevators and automatically deposited either in the warehouse or in the hold of vessels. It is believed this will be the most completely equipped warehouse of the kind in the country when done.

THE Pabst Electric Light, Heat & Power Company, Milwaukee, is erecting a power house and will make it a model plant in every respect. The company has just accepted a proposition from the Link-Belt Machinery Company, Chicago, for a complete system of elevators and conveyers for supplying coal to the boilers and removing the ashes. The economy and convenience of labor-saving machinery of this character in boiler houses is being very generally appreciated.

THE Wisconsin Central Railroad has just commenced work on the foundations for a freight house, to be located on their property in Chicago, below Harrison Street, and on the east side of the river. The structure will be 500 ft. long, have a water frontage its entire length, and will be 95 ft. wide and three stories in height. A liberal use of labor-saving machinery is intended to facilitate the handling of all kinds of freight.

A PRESS dispatch says that the Schoen Pressed Steel Brake Beam Company, of Pittsburgh; the Universal Brake Beam Company, of St. Louis; the Michigan Railway Supply Company, of Detroit, and the Northwestern Railway Supply Company, of Chicago, have formed a combination to be known as the American Brake Beam Company. H. W. Oliver, of Pittsburgh, is the temporary President. The main office will be in Chicago. The incorporated capital is $2,500,000.

A LARGE order for hydraulic projectile drawing presses has been awarded to Messrs. Watson & Stillman, of New York, by the United States Projectile Company of Brooklyn. Orders for hydraulic presses, pumps and accumulators have been so abundant during the past year that it has been found necessary to operate their plant both day and night, notwithstanding increased facilities in the several departments.

THE New York Locomotive Works, in Rome, N. Y., were sold October 27 by the Referee, and were bought by a committee representing the holders of first-mortgage bonds for $197,074, subject to the mortgage of $150,000. The purchasers will organize a new company and will put the works in operation again; but it is said that they will not continue the construction of locomotives.

RECENT orders at the Baldwin Locomotive Works, Philadelphia, include 45 consolidation freight engines for the Pennsylvania Railroad, and 50 locomotives for the Philadelphia & Reading.

THE Chester Steel Casting Company is about to erect an enlargement to its foundry 50 × 50 ft., a furnace house 40 × 40 ft. and a gas house 50 × 80 ft.

THE Corliss Steam-Engine Company, Providence, R. I., is building a 500-H.P., cross-compound condensing engine for the American Screw Company. The engine has a stroke of 4 ft., and its cylinders are 20 and 36 in. in diameter.

THE Buffalo Car Wheel Foundry Company has been organized and will build works in Buffalo, N. Y., with a capacity of 500 car wheels a day.

THE Thurmond Car Coupling Company has leased all its appliances, including the coupler and McKeen tender hook and carry iron, to Isaac G. Johnson & Company, of Spuyten Duyvil, N. Y., manufacturers of steel and malleable iron. T. L. McKeen has leased his continuous platform and buffer to the same firm, and will have charge of the manufacture of the appliances. The office at 80 Broadway, New York, will be continued, with Mr. Hascall in charge, representing Johnson & Company.

PERSONALS.

WILLIAM KENT has removed his office as Consulting Engineer and Metallurgist to No. 35 Warren Street, New York City.

G. BACON PRICE has opened an office as Mechanical Engineer at No. 308 Walnut Street, Philadelphia. Mr. Price was for a number of years Chief Examiner at the Baldwin Locomotive Works.

A. FTELEY, Chief Engineer of the New York Aqueduct Commission, recently delivered an interesting and valuable lecture on the Construction of Dams before the students of the Rensselaer Polytechnic Institute in Troy.

J. W. SHANKS has been appointed General Roadmaster of the Central Vermont Railroad, succeeding A. C. BEAN, deceased.

L. C. FRITCH has been appointed Chief Engineer of the Ohio & Mississippi Railroad, succeeding C. C. CHANDLER, who has resigned.

A. LEOFRED, Mining Engineer, of Quebec, reports much interest in mining matters. He is constantly employed in examining and reporting on mining properties.

COLLINGWOOD SCHREIBER, for some years past Chief Engineer of the Canadian Department of Railways and Canals, has been appointed Deputy Minister of the Department. He will still remain Chief Engineer.

H. B. HODGES has been appointed Engineer of Tests of the Baltimore & Ohio Railroad, to succeed L. S. RANDOLPH, resigned. Mr. Hodges was formerly Superintendent of Tests of the Union Pacific Railway.

C. E. FULLER, JR., has been appointed Superintendent of Motive Power of the Central Vermont Railroad, with office at St. Albans, Vt. He has been for some time on the New York, Lake Erie & Western road.

F. R. F. BROWN has been appointed Mechanical Superintendent of the Intercolonial Railway. He has served on the Grand Trunk and the Canadian Pacific, and has recently been Superintendent of the Dominion Bridge Company.

W. J. ROBERTSON, for some time past Superintendent of Motive Power of the Central Vermont, has been appointed Master Car-Builder, and will have entire charge of the Car Department, which has been separated from that of Motive Power.

OBITUARIES.

COLONEL ROBERT C. MORRIS, who died in Nashville, Tenn., November 8, was born in Tennessee in 1817. He served as Assistant and Resident Engineer on the East Tennessee, Virginia & Georgia for some time, and since 1869 had been Chief Engineer of the Nashville, Chattanooga & St. Louis Railroad. Nearly all the branches and extensions of that road were located and built under his direction.

ZENAS KING, the well-known bridge-builder, died in Cleveland, O., October 25, aged 74 years. Born in Kingston, Vt., and engaged on the farm until he reached man's estate, his start in business was as a contractor for the erection of buildings. His mechanical skill, developed in this work, came to his help later, when as a traveler for the Mosley Bridge Company he began studying to improve upon wooden bridges. In 1861 he obtained a patent for the King iron bridge, and erected works in Cleveland to manufacture bridges and boilers. His partner, Mr. Freese, took the boiler department on the dissolution of the firm some time later. Mr. King resolutely pushed his business, and succeeded by hard work in introducing them on highways all over the country. In 1871 he organized the King Bridge Company, of which he was, at the time of his death, the President and Manager. In recent years Mr. King was very largely interested in the building of long bridges. The finest of that character is the one between Covington, Ky., and Cincinnati. Last winter he engaged in an enterprise to build another bridge between Cincinnati and Newport. About a year ago a company, in which he was largely interested, was chartered in New York State for the purpose of building another bridge from New York City across the East River.

PROCEEDINGS OF SOCIETIES.

American Railway Association.—The semi-annual meeting of the American Railway Association was held at No. 24 Park Place, New York City, on Wednesday, October 12, 1892; the President, Mr. H. S. Haines, in the chair.

Fifty-eight representatives, representing 42 roads, were present.

The date selected for the general fall change of time-tables was November 13.

The Executive Committee reported having received applications for membership from the Boston & Maine, Chattanooga Southern and the Concord & Montreal Railroad companies, which have been duly approved; making the total membership 180 companies, operating 128,062 miles of road.

The following-named gentlemen were appointed on the Nominating Committee: C. H. Platt, F. S. Gannon, C. Neilson.

The President's address was then delivered. It treated chiefly of the block system of operating and of needed improvements in the rules for operating.

Some new Rules, to Prevent the Misuse and Diversion of Freight Cars were adopted, to take effect January 1, 1892:

The Committee on Train Rules proposed some changes in the Standard Code, which were adopted by the Association.

The Committee on Safety Appliances reported that the subject of Interlocking and Block Signals had been referred to a joint sub-committee, consisting of members selected from the Committee on Safety Appliances and the Committee on Train Rules.

The following companies were elected members of the Committee on Car Service, their terms to expire in October, 1895: Pennsylvania Railroad; Chicago, Rock Island & Pacific Railroad; Lake Shore & Michigan Southern Railroad.

The following companies were elected members of the Committee on Safety Appliances, their term to expire in October, 1895: Pennsylvania Railroad; Delaware & Hudson Railroad; Old Colony Railroad.

A resolution was offered that the next (April) meeting of the Association be held in the city of Chicago, which was adopted, after which the meeting adjourned.

Roadmasters' Association of America.—The annual convention met in Chattanooga, Tenn., November 15, with a large attendance. On the following day the members proceeded by special train to Atlanta, Ga., where the rest of the sessions were held.

The meeting was carried out according to the programme already published, and was a successful one. A fuller report will be given later.

American Association of Superintendents of Bridges & Buildings.—The annual convention was held in Cincinnati, October 18 and 19. A large number of new members were admitted.

The following officers were elected: President, H. M. Hall, Olney, Ill.; Vice-Presidents, J. E. Wallace, G. W. Hinman, N. W. Thompson, C. E. Fuller; Secretary, S. T. Patterson, Concord, N. H.; Treasurer, G. M. Reed, Cleveland, O.; Executive Committee, G. W. Andrews, J. Staten, J. M. Caldwell.

Reports were presented by committees on Paints for Iron Structures; Surface Cattle Guards; Frame and Pile Trestles and Rerailing Frogs; Interlocking Signals; Iron and Vitrified Pipe Culverts; Water Tanks; Framing Wooden Trusses and Protecting them from Fire and Decay, and Depot Platforms.

The Report on Painting recommended pure linseed-oil and lead as the best paint for iron exposed to the weather. The Cattle Guard Committee presented two reports, one favoring the pit guard, the other the surface guard. The report on Pipe Culverts favored iron pipe, and claimed that vitrified pipe gave trouble by breaking at the ends from the action of frost. Vitrified pipe was recommended for use on sidings and in place of wooden sluice boxes at road crossings. The report on Wooden Bridges gave the average life of unprotected wood trusses at 7½ years, the parts which fail first being the lower chord, clamps and packers. Roofing wooden bridges was not favored, on account of danger from fire; but it was recommended that the lower chords be covered with galvanized iron run under the angle-blocks and gib plates.

The next meeting will be held in Philadelphia in October, 1893. Among the subjects on which committees will report are the following: Discipline, Turn-tables, Water Columns, Coaling Stations, Creeping of Rails, Bridge Guard Rails, Platforms, Bridges for Spans above 130 ft.

American Society of Mechanical Engineers.—The winter meeting was to be held in New York, beginning November 29. The programme arranged is as follows:

Tuesday, November 29.—Evening, opening meeting and delivery of the President's address.

Wednesday, November 30.—Morning, meeting for business, reading of papers and topical discussions. Afternoon, visits to points of interest about the city. Evening, reception and conversazione.

Thursday, December 1.—Morning, session for reading of papers and discussion. Afternoon, visits to points of interest. Evening, session for reading of papers.

Friday, December 2.—Morning, session for reading of papers and for concluding business.

American Society of Civil Engineers.—At the regular meeting, November 2, the committee appointed to prepare a memoir of James B. Francis, resigned, and at its own request was succeeded by his intimate friends, the Past Presidents George S. Greene, William E. Worthen and Julius W. Adams.

The Secretary read a paper on Electric Rock Blasting—the American Method, by W. L. Saunders. This was followed by an interesting discussion.

The tellers announced the following elections:

Members: Professor William W. Carson, Knoxville, Tenn.; Horace Harding, Tuscaloosa, Ala.; Benjamin S. Wathen, Dallas, Tex.; Professor J. H. Kinealy, St. Louis.

At the regular meeting, November 16, a paper on Repairs and Maintenance of Roads was read by James Owen, and was discussed at some length by members present. The Secretary urged all to use every opportunity to help in securing better road laws.

Canadian Society of Civil Engineers.—At the regular meeting in Montreal, October 28, the first order was the discussion of Mr. Gilpin's paper on the Use of Safe Explosives in Coal Mines.

The discussion was followed by the reading of a paper by Mr. H. R. Lorde on Transition Curves. This was followed by a brief discussion.

At the regular meeting in Montreal, November 11, the first order was the discussion of Mr. H. R. Lordly's paper on Transition Curves, read at the preceding meeting.

Mr. D. H. Keeley then read a paper on the Simplification of the Quadruplex. Discussion was postponed to the next meeting.

American Society of Irrigation Engineers.—This society, organized some time ago at Salt Lake City, has elected the following-named officers: President, Arthur D. Foote, Boise, Idaho; Vice-President, G. G. Anderson, Denver, Col.; Secretary and Treasurer, C. L. Stevenson, Salt Lake City, Utah. The Board of Directors is Professor L. G. Carpenter, Fort Collins, Col.; Harry I. Willey, San Francisco; J. S. Greene, Denver. The headquarters remain at Salt Lake City.

Franklin Institute.—At the regular meeting, in Philadelphia, October 19, Mr. F. Lynwood Garrison was elected a member of the Committee on Science and the Arts in place of Dr. George A. Koenig, resigned.

Mr. F. E. Ives read a paper descriptive of the principles of construction and operation of the Heliochromoscope, a new optical instrument of his invention for the reproduction of natural colors in photography.

Mr. S. Y. Buckman described an automatic Tin-plate Machine of his invention, and in connection therewith gave a sketch of the present state of the art of making tin plates.

Mr. W. E. Lockwood described the Boyer Railroad Speed Recorder and an Improved Smoke and Spark-consuming Device in Locomotive Practice.

New York Railroad Club.—At the regular meeting, October 20, there were no papers announced, but several topics had been selected by the Executive Committee for discussion. The talk of the evening was opened by Mr. W. G. Berg, Engineer Lehigh Valley Railroad, on the subject of the Best Plan for Railroad Shops, Rectangular or Radial. Mr. Berg spoke at considerable length, and was followed by Mr. Forney, who described in some detail with blackboard sketches a plan of shops that he had recently recommended, in which the several buildings were grouped around and commanded by a central turntable.

Another topic discussed was Locomotive Driving-Wheel Boxes, with special reference to the best way of lining them up to reduce lateral play.

At the annual meeting, November 17, the following officers were elected: President, R. C. Blackall; First Vice-President, George W. West; Second Vice-President, A. E. Mitchell; Third Vice-President, W. H. Lewis; Secretary, J. A. Hill; Treasurer, C. A. Smith; Executive Committee, Thomas Millen, W. C. Ennis, H. H. Vreeland, W. W. Snow and W. G. Wattson; Finance Committee, Thomas Prosser, E. H. Andress and F. M. Patrick.

Boston Society of Civil Engineers.—At the regular meeting in Boston, November 16, Mr. E. K. Turner read a paper on English Railroads, and a general discussion followed.

New England Railroad Club.—At the regular meeting in Boston, November 9, the subject of the System and Appliances Necessary for Higher Speed of Trains was opened by Mr. C. A. McAlpine, who spoke at considerable length. An interesting discussion followed, in which Messrs. Chamberlain, Marden, Coughlin, Lauder and others took part.

Engineers' Club of Philadelphia.—At the regular meeting, October 15, Mr. John C. Trautwine, Jr., presented notes on the Distribution of Pressure in Masonry Joints, illustrated with sketches on the blackboard.

Mr. Wilfred Lewis gave an account of his Investigation of the Strength of Gear Teeth, beginning with a reference to the elementary character of the problem and the great diversity of rules adopted by many recognized authorities, and showing that although the form of a tooth had long been known to be an important factor in the determination of its strength, none of the rules in common use took account of the strength as affected by the number of teeth in the wheel or pinion.

Virginia Association of Engineers.—At the fall meeting, held at Roanoke, Va., October 22, a report on country roads was made by Oscar Saabye and Clarence Coleman. The report cited the difficulties in the way of building good roads in Virginia, and submitted plans of cross sections for earth, gravel and macadam roads.

The report advocated the repeal of the personal labor law and the enacting of a wide-tire law with a refunding provision.

The Association will meet monthly hereafter.

Engineering Association of the South.—The regular October meeting of this Association was held in Nashville, Tenn., October 13.

Mr. Ernest William Walpole, City Engineer of Talladega, Ala., was elected a member.

The programme of the evening included two papers; the first on the Mining Interests of Nova Scotia, by Mr. Frank Cawley, of Montreal, Canada.

Mr. Thomas Sharp, of Nashville, then presented a paper on the Spathic Ores and Iron of Lawrence County, Tennessee.

Engineers' Society of Western Pennsylvania.—At the regular monthly meeting, October 18, Mr. W. G. Wilkins was appointed to obtain papers from the members to be read at the Congress of Engineers, Columbian Exposition, on the list furnished by the American Institute of Civil Engineers.

The following applicants were elected to membership: Maurice Coster, W. A. Corcoran, George F. Greenwood, W. A. Herron, W. H. Hays, Walter H. Jackson, Horace W. Lash, William G. Musse, Reuben Miller, Jr., H. H. McClintic, Charles H. Snyder.

Mr. George H. Hutchinson then read a paper on Mill Building Construction, presenting a brief statement of the more important conditions which should govern the design and construction of modern mill buildings.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held November 8. John G. Oliver and George C. Bardons were elected active members, and Charles Orr an associate member. The paper of the evening was read by Dr. E. W. Marley, Professor of Chemistry of Adelbert College, on the subject of Weighing Gases, in which some important and interesting experiments for the determination of atomic weights were described.

Michigan Engineering Society.—The Board of Directors met in annual session at Grand Rapids, Mich., October 12, and after canvassing the letter ballots for the election of officers, announced the election of the following-named persons: President, E. W. Muenscher, Manistee; Vice-President, George Pierson, Kalamazoo; Secretary and Treasurer, Frank Hodgman, Climax; Directors, Dorr Skeels, Grand Rapids; William Appleton, Lansing; Professor E. A. Davis, Ann Arbor. The annual meeting of the Society will be held in Lansing the third week in January, and one session will be devoted to the consideration of the road improvement problem. The Society has 150 active members.

Engineers' Club of St. Louis.—At the regular meeting of October 19, the by-laws were amended.

Mr. W. H. Bryan then read the paper of the evening on Steam Engine Efficiency: Its Possibilities and Limitations. Mr. Bryan called attention to the popular idea of steam-engine efficiency, alluding briefly to failures which had occurred in attempting to secure expected results from high efficiency machinery. He dwelt upon the ideal engine as distinguished from the real engine met with in every-day service, and showed that the perfect engine itself is of low efficiency on account of the narrow limits of temperature within which it is possible to work.

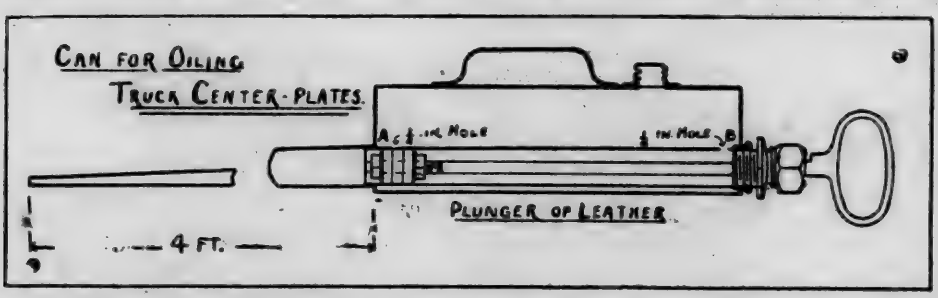
Discussion followed by Messrs. Olshausen, Seddon, Laird, Johnson, Perkins and Schlosser.

NOTES AND NEWS.

A New Steamer for Long Island Sound.—Work has been begun at the Delaware River Iron Ship-building & Engine Works, Chester, Pa., on a new boat for the Old Colony Steamboat Company, which is to exceed the well-known *Puritan*, *Pilgrim* and *Plymouth* of the company's Fall River line, in size and general excellence of her appointments. The new boat will be 440 ft. long over all; 424 ft. on water-line; 20 ft. 6 in. depth of hull; beam over hull, 52 ft.; beam over guards, 92 ft. She will be constructed entirely of steel, and will be absolutely fire-proof. She will have a double hull on the bracket system, divided into 58 water-tight compartments. The motive power will be supplied by double inclined compound engines of 8,000 H.P., working side-wheels with feathering buckets, and the boat will be fitted with 10 Scotch boilers and two smoke-stacks. The speed expected to be obtained is 22 knots per hour. Accommodation is planned for about 1,500 passengers in between 400 and 500 state-rooms; while the freight-carrying capacity will be 1,000 tons or more. The general design and arrangements are almost similar to those of the *Puritan*, with the exception of the saloon, which will be placed on the main deck aft, instead of below. The cost is calculated to reach the neighborhood of $1,250,000.

A Remarkable Gun.—A cannon which is preserved in the War Museum in Vienna can boast of an adventurous career. It was cast in the year 1568 by the then renowned gunmaker, Herr Hans Christoph Löffler, whose foundries were situated a Hütting, near Innsbruck, and it is of the class of ordnance known as the three-quarter carronade. In addition to the name of the Emperor Maximilian II., it bore, and still bears, the following inscription: "Ich bin ein Hahn—ein redlich Mann—der krähen kann—dass Thurm und Maver—zu Boden gan," a specimen of mediæval German doggerel which is intended to signify that the weapon is a cock which, by its crowing, can cause towers and walls to fall. At Raab this bronze chanticleer, as Arabic engraving clearly indicates, came into possession of the Turks, and it was conveyed to Serajewo, whence it was dispatched to the border fortifications at Kanisa. On April 1, 1692, it was recaptured by the Austrians when General Batthyanyi stormed the Hungarian fortress. In the year 1738, at Belgrade, the gun found itself once more in the hands of the Moslems. Then all trace of it was lost until in 1878 the Hapsburg troops discovered the old and now much battered cannon among the artillery of the Herzegovinians at Mostar.

A Handy Center-plate Oiler.—The sketch given herewith shows an oil can used on one of our leading railroad lines for oiling the truck center-plates of freight cars. The can is made of galvanized iron and is 3 in. in diameter and 10 in. long; the spout is 1 in. in diameter at the end next the can, and tapers down in a length of 4 ft. to ¼ in. As will be seen by the sketch, which shows the can in section, it has a barrel 1 in. in diameter in which works a plunger made of leather and secured to a ¼-in. rod with threaded end by two nuts and washers, one on each side. In addition to holding the leather piston in place these serve to keep it tight in the barrel, all that is necessary being to screw up the outer nut occasionally. The can is provided with a filling hole, covered by an ordinary zinc screw-cap, and has a handle on one side.



The oil is admitted to the barrel by a ¼-in. hole at *A*; this is kept closed by the plunger when the can is not in use, preventing oil from leaking into the barrel and wasting through the spout. The second ¼ in. hole at *B* is provided in order to dispose of any oil that might leak into the barrel behind the plunger; it also serves to aid the flow through the hole *A* when the plunger is drawn back.

The method of using this oiler will readily be understood. The advantage of keeping the center-plates oiled in reducing friction on curves is well understood; but on too many roads it is not done at all, and on others only irregularly and with but little care.

An Old Railroad.—By the courtesy of a gentleman in Birmingham who has a large collection of railway curiosities, we are enabled to give a representation of a medal referring to the Gloucester & Cheltenham Railway. The Act of Parliament under which that line was constructed was obtained in 1809, and was entitled "An Act for Making and Maintaining a Railway or Tramroad from the River Severn at the Quay in the City of Gloucester to or near a certain Gate in or near the Town of Cheltenham . . . called the Knapp Toll Gate, with a collateral branch to the Top of Leckhampton Hill." The preamble sets forth that the traffic between Cheltenham and Gloucester is very

AN OLD RAILROAD MEDAL.

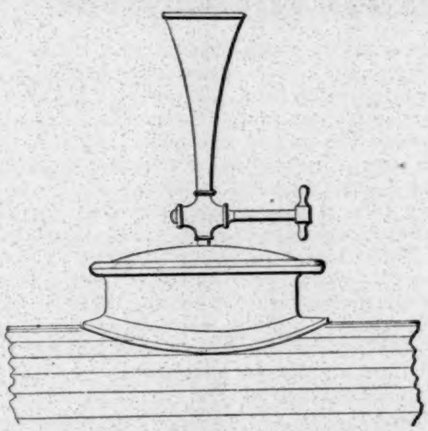
great, and the road is much injured by the heavy carts and wagons passing over it. The construction of a railway or tramroad for conveying stone from the quarries at Leckhampton to the port of Gloucester, and for the conveyance of general merchandise between the two towns, would, it is stated, be very advantageous; and a number of persons are incorporated under the title of the "Gloucester & Cheltenham Railway Company," with power to raise a capital not exceeding £35,000, and to construct and maintain such railway. The Act is of considerable length, and contains minute provisions as to the manner in which the undertaking is to be carried out. Steam-engines are naturally not mentioned, the hauling is to be by "men, or horses, or otherwise." We learn incidentally that the rails were to be of the "plate" kind, furnished with a flange on the outer side to form a guide for the wheels. In 1815 a further Act was obtained, authorizing the raising of additional capital to the extent of £15,000. The date of opening does not seem to have been recorded, but it appears to have been finished in 1819, as it is indicated in "a Geological Map of Gloucestershire," published in that year by the well known William Smith, "the father of English geology," as he has been well called. The line starts from Leckhampton, and joins the high road between Cheltenham and Gloucester, just outside the former town, whence it runs parallel to the road for some distance. About a mile from Gloucester it takes a curve, and enters the city at the opposite side. We are unable to give any information as to the object of the medal, or the date when it was struck. The locomotive is obviously of the *Agenoria* and *Stourbridge Lion* type, the former of which may be seen at South Kensington. They were built at Stourbridge, by Messrs. Foster & Rastrick, in 1828 and 1829 respectively, but the medal must certainly be subsequent to the accession of William IV., in 1830. It has been suggested that it was a first-class pass, perhaps issued to the directors, but if so, it would hardly have been struck in copper, as this is, and would not have been so large and heavy. A writer in the Local Notes and Queries column of the Birmingham *Weekly Post* of September 22, 1888, says that the tramway was in use some years after the present railway between Gloucester and Cheltenham was opened, and that in his boyhood he had many a ride upon the trucks which brought the stone from the quarries at Leckhampton. We believe that a portion of the tramway at the Leckhampton end is still in use.—*The London Engineer.*

A Physical Evil of Electric Welding.—A section of the men employed at the Kolomna Ironworks, in Russia, has lately had some unpleasant experiences with electric welding, which, with the aid of 500 accumulators, is there practised according to the Benardos process. While engaged on the trying work the artificers' eyes were, of course, protected by tinted glasses, but the skin being exposed, the following symptoms were manifested: Burning sensation on the skin and in the eyes; in from three to four hours, discharges from the nose

and the eyes; three to four hours later a dry cough; four to five hours later, swelling of the skin and development of other symptoms; eight to ten hours from the commencement of the disorder, continuous irritation of the eyes, lasting from four to six hours; and finally, coloring of the skin. Then the various effects ceased, and the skin began to peel. On the third day the cuticle had completely decorticated, and by the sixth all the painful symptoms disappeared. But for weeks afterward the skin remained colored. These effects, it would seem, are exactly the same as those which are induced under scorching by the sun. The best protection which can be afforded the workmen against the evils mentioned, M. Maklakoff, the Manager of the works, believes, consists in a covering of yellow waxed-cloth or red and green veils. The electric welders, however, object with characteristic Russian dignity to the assumption of the feminine facial appendages, alleging that although they may improve the general appearance of the fair sex, they will rather excite ridicule when they are worn by stalwart workers.—*Iron.*

The Locomotive Whistle.—Mr. Clement E. Stretton, C.E., writes to the *English Mechanic* as follows: "The invention of the first steam trumpet or whistle for locomotive engines has lately received much attention. The following facts and illustration may therefore prove of interest to your readers:

"During the first few weeks of the year 1833 the Leicester & Swannington Railway Company's engine, the *Samson*, ran into



THE FIRST LOCOMOTIVE WHISTLE.

a horse and cart crossing the line at the 'Stag and Castle,' Thornton, the cart being loaded with butter and eggs for the Leicester market.

"The engine-driver had only the usual horn, and could not attract attention. Mr. Ashlen Bagster, the Manager of the railway, went the same Saturday afternoon to Alton Grange, Snibstone, to report the circumstance to Mr. George Stephenson, who was one of the directors and the largest shareholder. After various ideas had been considered, Mr. Bagster remarked: 'Is it not possible to have a whistle fitted on the engine which steam can blow?' George Stephenson replied: 'A very good thought; go and have one made.' And such an appliance was at once constructed by a local musical-instrument maker. It was put on in ten days and tried in the presence of the board of directors, who congratulated both Bagster and Stephenson, and ordered more trumpets to be made for the other engines which the company possessed.

"The company had to pay for the horse and cart, 50 lbs. of butter and 1,000 eggs; after which strict instructions were issued that 'under no circumstances should any of the company's locomotive engines run unless fitted with the steam trumpet.'

"The annexed diagram is taken from the official drawing signed by Mr. H. Cabry, the company's Engine Superintendent, May, 1833."

Electric Locomotives in London.—In a recent paper Mr. A. Siemens has given some particulars in relation to the electric locomotives built by his firm for the City & South London underground road in London. These locomotives are mounted on four wheels and have a motor on each axle. The weight of the locomotive is 15½ tons, and the usual weight of train is 28 tons.

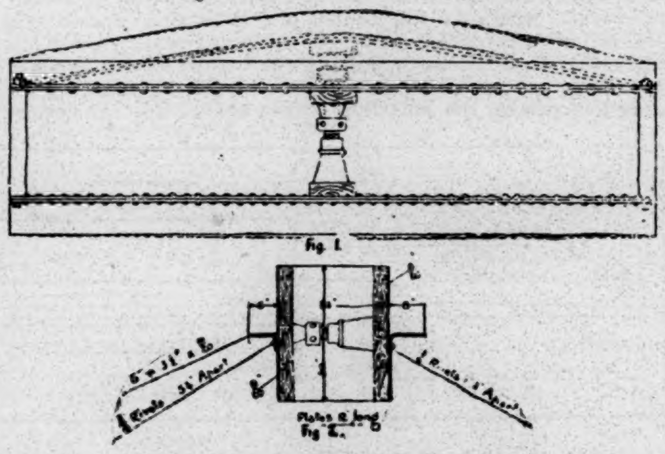
Careful experiments showed that at speeds varying from 12 to 30 miles an hour the power required varied from 53 to 120 H.P. The economic return was found to equal 92 to 94 per cent. of the power furnished. The current does not usually exceed 50 amperes, except in starting trains, when it sometimes rises to 140 amperes.

A New Gradient Indicator.—The firm of Brown Brothers, of Bristol, England, have recently brought out a self-adjusting gradient indicator for surveying, mining, and sanitary work, an illustration of which is given herewith. This instrument combines, in a convenient form, a set of spirit tubes, two of these being curved in such a manner that on application to any given surface the air bubble will become stationary opposite the point indicating the gradient of the surface to which it is applied. The long tube is used for all indications from 1 in 2

GRADIENT INDICATOR.

to 1 in 200 from horizontal positions, and has a point-showing level, the short tube being used for all vertical work, indicating by the position of the bubble gradients from 15° to plumb; thus, supposing the fall of surface to be 1 in 30, the bubble will float midway to the point marked 30 on the plate enclosing the long tube; or if a batter of, say, 45° is being tested, it will be found that the bubble is floating midway to a point marked 45° on the indicating plate enclosing the shortened tube upon the application of the instrument to the surface. It will thus be seen that the instrument indicates at a glance and without setting the inclination of a surface to which it is applied, and there are no parts to adjust or become worn.—*Industries.*

Bulkhead Stiffening.—The question of the efficiency of water-tight bulkheads under the strains brought to bear upon them through the compartments being flooded, in the event of damage to the hull of the vessel by collision, sunken rocks, or other causes, has called forth a great deal of careful thought. And in view of the many and diverse opinions, the experimental test lately carried out on behalf of Lloyd's under the supervision and direction of their surveyors, by Messrs. A. & J. Inglis, of the well-known ship-building firm of Pointhouse, Glasgow, is of great value, as giving some reliable data. In view of the introduction of flanged plates in place of the usual method of stiffening the bulkheads by angle-irons, Lloyd's gave instructions to prepare two test strips of bulkhead, as per fig. 2, to Messrs. A. & J. Inglis (to whom we are indebted for the illustration), which were each 12 ft. long and 30 in. wide, the one being of the usual design, consisting of a plate 0.4 in. thick, stiffened by an angle iron 6 in. × 3½ in. × ½ in. riveted on by rivets ¾ in. in diameter and 5¼ in. apart; the other was of the flanged plate design, and consisted of two plates 0.4 in. thick, the edge of the one being flanged out 8 in. and the two plates riveted together with rivets ¾ in. in diameter and 3 in. apart.



TESTS OF BULKHEAD BRACING.

The two strips were rigidly connected at the ends, and were forced apart with a screw-jack placed between them in the center. It was found that the strip of bulkhead stiffened by the angle iron gave way, as shown by the dotted lines in fig. 1, while that stiffened by the flanged plate had practically retained its position, the defection being very slight. This power of resistance is of most vital importance, as even the straining of the bulkheads by the weight of the cargo resting against them when the opposite side is not similarly supported, too often renders them useless as a water-tight bulkhead, and they become simply partitions for cargo purposes.—*Shipping World.*